A STUDY ON CLINICAL AND RADIOLOGICAL OUTCOME OF PROXIMAL TIBIA FRACTURE WITH DUAL PLATING

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Dedicated to

My

Family, friends

and

Teachers

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ABSTRACT

INTRODUCTION: - The tibia plateau is amongst the most important weight bearing regions of the human body. Intra-articular fractures of the proximal end of tibia are serious complex injuries and difficult to treat. Proximal tibia fractures account for 1.2% of all fractures in adults. The majority of fractures occur in males (70%) with men aged 41–50 years being the most affected patient population overall. Comminuted fractures are more common in males. Such injuries generally result due to high energy trauma, majority due to road traffic accidents and the rest are accidental fall from height or sports related.Treatement of proximal tibia fractures remains a topic of debate.With multitude of surgical procedures available,there still remains ambiguity regarding the ideal approach for tibial plateau fractures.The purpose of this study is to assess the clinical and radiological outcome of surgically treated proximal tibia fracture with dual plating.The details of history, clinical examination and radiological grading were entered into a performa.

Material and methods:- 37 patients of fracture proximal tibia who were evaluated at our centre between 1st june 2019 till 31st march 2022 were included in this retrospective and prospective study. Schatzker's classification was used to classify the fractures. Follow up was done at 4 weeks,6 weeks, 3 months and at 6 months.The radiological outcome was assessed by Modified Rasmussen Score for radiological assessment and clinical outcome was assessed by Modified Rasmussen Score for clinical assessment.

Results:- The mean age of the patients in our study was 42.7 years. Males were predominantly involved than females in our study. Most common mode of injury was road side accidents. Out of total 37 cases, 24 patients were Schatzker's type VI and 13 patients were Schatzker's type V.In our study, radiologically,5 patients had excellent score, 27 patients had good score, 5 patients had fair score while none of the patient was having poor score. Clinically, 13 patients had excellent score, 20 patients had good score,3 patients had fair score and 1 patient was having poor score. In our study,8 patients were having complications,out of which 3 patients were having hardware problems ,and 5 patients were having infections. Out of 5 patients who were having infections, 3 patients were having superficial infection,2 patients were having deep infection.

Conclusion:- Treatement of bicondylar tibial plateau fractures (Schatzker's type V &VI) with dual incision and dual plate provides good surgical exposure, minimal soft tissue complications rate, reasonable amount of stability, acceptable alignment of articular congruity, reasonable time to union and allow early range of motion of knee & early weight bearing with good radiological and functional results.

Keywords:- Bicondylar tibial plateau,Schatzker's classification, Modified Rasmussen's Radiological criteria, Modified Rasmussen's Clinical criteria

KEY TO MASTER CHART

SIDE	Left = 1 Right=2
GENDER	M= Male F=Female
RSA(ROAD SIDE ACCIDENT)	Y=Yes N=N
AFH(ACCIDENTAL FALL FROM HEIGHT)	Y=Yes N=N
POSTEROMEDIAL ANTEROLATERAL (AL)	PM= Posteromedial, DM= Direct Medial
OPEN/CLOSED FRACTURE	CF=Closed Fracture OF=Open Fracture
DISPLACED/UNDISPLACED FRACTURE	D= Displaced Fracture
ANAESTHESIA USED	GA= General Anesthesia SA=Spinal CSA=Combined Spinal Anesthesia
POST OP COMPLICATION	N=normal(no complication)
MODIFIED RASMUSSEN SCORE RADIOLOGICAL OUTCOME	
CW	Condylar Widening
VVA	Varus Valgus Angulation
OOST	Osteoarthritis
TOTA	Total Score
CAT • 1 • 2 • 3 • 4	Category Total Score • poor • fair • good • excellent

MODIFIED RASMUSSEN SCORE CLINICAL OUTCOME	
WC	walking capacity
KE	Knee Extension
TRM	Total range of movements
STAB	Stability
POQ	Power Of Quadriceps

LIST OF ABBREVIATIONS

CT	COMPUTED TOMOGRAPHY
HJS	HONKONEN JARVINEN SCORE
KOOS	KNEE INJURY AND OSTEOARTHRITIS OUTCOME SCORE
LCP	LOCKING COMPRESSION PLATE
LISS	LESS INVASIVE STABILISATION SYSTEM
MIPPO	MINIMALLY INVASIVE PERCUTANEOUS PLATE OSTEOSYNTHESIS
MRS	MODIFIED RASMUSSEN'S SCORE
OKSS	OXFORD KNEE SOCIETY SCORE
ORIF	OPEN REDUCTION AND INTERNAL FIXATION
POST OP	POST OPERATIVE
PRE OP	PRE OPERATIVE
ROM	RANGE OF MOTION
RSA	ROAD SIDE ACCIDENT
TPF	TIBIAL PLATEAU FRACTURES
WOMAC	WESTERN ONTARIO AND MCMASTER UNIVERSITIES OSTEOARTHRITIS INDEX

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INTRODUCTION

The proximal tibia is triangular in shape with a vast metaphyseal region narrowing distally. The knee has a medial and lateral tibial plateau, on which the menisci sit and articulate with the femoral condyles [1]. Tibial plateau fractures (TPFs) are unusual injuries caused by high or low energy, axial compressive trauma alone or in conjunction with varus or valgus knee stress [2]. These fractures account for less than one percent of all fractures [3]. Seventy percent of isolated tibial plateau fractures involve the lateral plateau, while twenty-five percent include the medial plateau [4]. These fractures are articular and pose a threat to the knee joint's functional integrity [5].

The age distribution is bimodal for both males and females which is similar to what is seen in other periarticular injuries [5]. The majority of fractures occur in males (70%) with men aged 40–44 years being the most affected patient population overall [6, 7]. Comminuted fractures are more common in males [8]. The highest incidence for tibial plateau fractures in females occurs between age 55 and 59 [7]. There is a shift of incidence between males and females that occurs after the age of 60 with females predominating (61%). With an increase in life expectancy as well as a large aging population in many developed countries it is expected that the incidence of low-energy tibial plateau fractures will continue to increase.

The injury mechanism seen in tibial plateau fractures is largely age-dependent. The majority of tibial plateau fractures in the elderly are due to force acting on the bone in conjunction with the bone quality determine the resulting fracture patterns [9]. Bone quality influences fracture energy falls. With an aging population and associated osteoporosis, the incidence of this injury is increasing. Osteopenia and osteoporosis play a large role in the fracture mechanisms and patterns observed. In the elderly, lateral fracture patterns are seen more commonly than medial. The injury patterns with low bone density decreases the force necessary for injury. A higher incidence of compression fracture patterns tends to be seen in such cases despite lower energy injury mechanisms. In the younger population, high energy mechanisms predominate. Male gender is more common. The injury mechanism can involve motor vehicles, sports, and fall from height. The most

common mechanism of injury overall is pedestrian struck by motorized vehicles (30%) and the second most common is low energy falls (22%) [10].

The magnitude and direction of the force of injury many times will influence the fracture pattern. Angular, axial, and compression forces can all lead to failure of the condyles. Axial load is usually a predominant component of the injury mechanism and produces higher energy at failure than angular forces. In general, greater axial load results in more severe fractures with increased comminution, fragment displacement, and associated soft tissue injury. In a cadaver study [11] that looked at mechanisms of injury it was found that pure valgus forces resulted in the typical lateral split fractures, axial forces resulted in joint compression fractures, and a combination of axial and valgus forces resulted in split depression fractures. The same study also concluded that an intact MCL is required for an isolated lateral plateau fracture to occur because the MCL acts as the pivot point causing the lateral femoral condyle to impact the lateral tibial plateau. The proximal tibia is more readily subject to valgus force because of an anatomic predisposition with 5–7° of knee valgus in normal anatomic alignment and due to lateral side impacts being a more common injury mechanism.

Tibial plateau fractures may be associated with injury to nearby structures including vasculature, nerves, ligaments, menisci, and adjacent compartments. While minimal tibial plateau fractures with no associated injuries can be safely managed non-operatively, but typically this injury requires orthopedic consultation and operative management [1].

The geometry and deviation of the fracture rely on a number of parameters, including the intensity and direction of the applied force, the degree of knee flexion at the time of the injury, and the quality of the bone. These fractures may be difficult-to-treat injuries and can afflict both young adults and the elderly [5].

Generally, tibial plateau fractures are categorized using either the Schatzker or OTA/AO systems. The Schatzker system defines these fractures as types I through VI, whereas the OTA/AO system classifies them as classes A, B, or C based on the severity of the injury and the degree of articular involvement [12, 13]. These fractures frequently involve extra soft tissue damage, which hinders the patient's rehabilitation following the initial injury [14].

When treating intra-articular fractures, the objective is to achieve a stable joint that allows early range of motion for cartilage nutrition and preservation [15]. Over the years, various therapy approaches have evolved, with variable effectiveness. Traction or closed treatment with cast bracing are examples [16]. Circular frames, percutaneous screw fixation, open reduction/internal fixation (ORIF), arthroscopically assisted reduction, fixed angle devices, novel grafting techniques, and arthroplasty have also been proposed [2, 5].

In general, tibial plateau fractures are to be operated on, but the decision whether to operate or not, depends on a specific fracture, based on the fracture morphology, the soft tissues and the patient's general condition, and the expected limb axis and articular surface restoration [5]. Usual indications for surgical treatment are: intra-articular displacement of ≥ 2 mm, metaphyseal-diaphyseal translation of > 1 cm, angular deformity of > 10° in the coronal (varus-valgus) or sagittal plane, open fracture, associated compartment syndrome, associated ligament injury requiring repair and associated fractures of the ipsilateral tibia or fibula [17]. Management in the early stages of treatment should focus on preventing further soft-tissue injury while waiting to repair the fracture [5]. Knee immobilization can be achieved by splinting or by external fixation. The use of a staged approach using external fixation is recommended in complex patterns and high-energy trauma, especially in cases of axial instability.

The main objective for definitive treatment of articular fractures of the knee are the restoration of articular congruity and stability, the axial and rotational alignment of the limb, and stability and early motion of the joint [5]. The eventual alignment of the knee after fracture healing is determined by a combination of the presence or absence of extra-articular fracture deformity, residual articular depression, and knee instability

As per the Schatzker classification bicondylar tibia plateau fracture falls under type V and VI [15]. Surgical fixation of bicondylar tibia plateau fracture is complicated because of metaphyseal and articular comminution and the frequent occurrence of associated soft tissue injuries. Treatment goals include restoration of articular congruity and alignment in the lower extremity and preservation of soft tissues and achieving functional range of knee motion. To achieve these goals open reduction and internal fixation is mandatory. For

open reduction and internal fixation of bicondylar tibia plateau fractures, several operative treatment options can be used like-

a. Isolated lateral locking plate

b. Dual plating with lateral locking plate and posteromedial buttress plate

c. Hybrid external fixator

d. Ilizarov

e. LISS (less invasive stabilisation system)

Each technique has its own merits and demerits. The use of Isolated Lateral Locking plate and Dual Plates is still a debate. Patients treated with isolated lateral locking plates had a high risk of loss of reduction and increased incidence of malunion [18]. Lasanianos et al. showed that collapse of medial tibia plateau occurred in isolated lateral locking plates when he compared the biomechanical properties of intramedullary nail, dual plates and isolated lateral locking plates [19]. While Ilizarov fixation and Hybrid external fixation seems reasonable methods of fixation of these fractures, there are a few problems including the insufficient fracture reduction [20, 21],inconvenience of an external fixator that requires careful maintenance, possibility of pin tract infections, joint capsule penetration with resultant septic arthritis, subsequent collapse of fracture fragments [22], and prolonged hospitalization [23].

However they are useful in the treatment of open schatzker type V and VI tibial plateau fractures [24]. Though LISS (Less Invasive Stabilization System) permits direct fracture reduction; fixed angle construct, percutaneous sub muscular implant, the cost is high. Gosling et al. reported significant malreduction in 16 of 69 bicondylar fractures treated with LISS [20]. Dual Plating is preferred over other techniques as it has several advantages: Better visualisation of fracture fragments, especially posteromedial fragment and articular surface [20], dual incision reduces wound complications [20], both lateral and medial columns are fixed to obtain stability, achieves interfragmentary compression [18], rigid construct [18].

The main keys for successful functional outcomes of tibial plateau fracture surgery are the restoration of the axial and rotational alignment of the limb and knee stability [1]. Anatomical reduction and restoration of articular congruity are critical but less important when it comes to functional results [1]. Another crucial aspect is soft tissue management. Initial management

involves preventing further soft tissue injury until the fracture is stabilized. This can be achieved by knee immobilization and cryotherapy [25].

Subsequent therapy comprises varying durations of weight-bearing restriction and immobility. According to studies the final functional outcome of TPF is dependent on the following factors: the degree of joint depression, extension and separation of the fracture line of the tibial condyles, the degree of comminution, metaphyseal and diaphyseal dissociation, and the integrity of the soft tissue envelope [26].

Several validated patient-reported instruments have been developed to assess functional outcomes following treatment for tibial plateau fracture. The Knee Injury and Osteoarthritis Outcome Score (KOOS), the Western Ontario & McMaster Universities Osteoarthritis Index (WOMAC), and the Modified Rasmussen's Score are examples (MRS). Several studies have found that the functional outcome of TPF therapy is favourable, with reported patient satisfaction rates ranging from 65 to 85 percent [27].

Dual plating via two incision techniques has received recent support because it allows for direct visualization of the articular reduction while minimizing the need for stripping off the soft tissue in the fracture area [28].

In our study, we have studied the clinical and radiological outcome of surgically treated proximal tibia fracture with dual plating. The radiological and clinical outcome were assessed after a minimum follow up period of 6 months using Modified Rasmussen Score for radiological assessment and Modified Rasmussen Score for clinical assessment scale respectively .

AIMS & OBJECTIVES

AIM: To assess the clinical and radiological outcome of surgically treated proximal tibia fracture with dual plating.

OBJECTIVES:

To assess the clinical outcome associated with dual plating in terms of

A. knee range of movements

B. pain relief

C. return to daily activities and work

To assess the radiological outcome of fractures after initial fixation with dual plating

REVIEW OF LITERATURE

ANATOMY

A good understanding and analysis of various anatomical structures around knee and biomechanics of knee is very much essential to pre operatively plan for surgical management, articular surface reconstruction and post-operative care to expect the probable complications after injury to proximal tibial region. The tibia is the medial and the larger bone of the leg. It is homologous with the radius of the upper limb.

KNEE JOINT:

It is a large joint of the lower limb. It consists of the relationship between three joint articulations

a) Patello femoral joint (saddle joint)

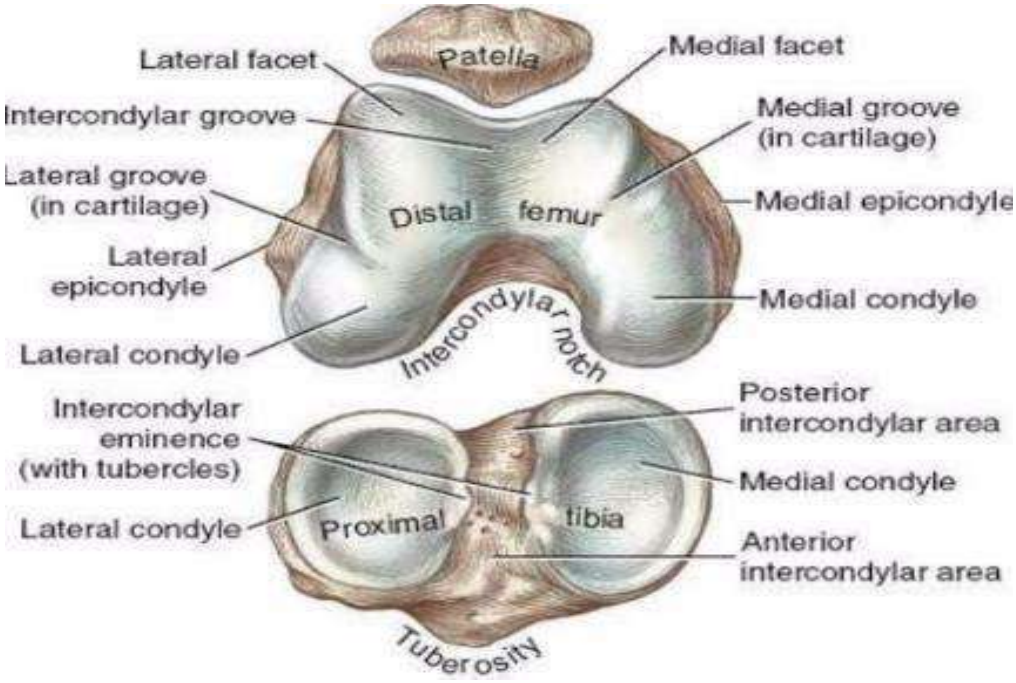
b) Tibio femoral joint (condylar joint)

c) Tibio fibular joint (condylar joint) [29, 30, 31]

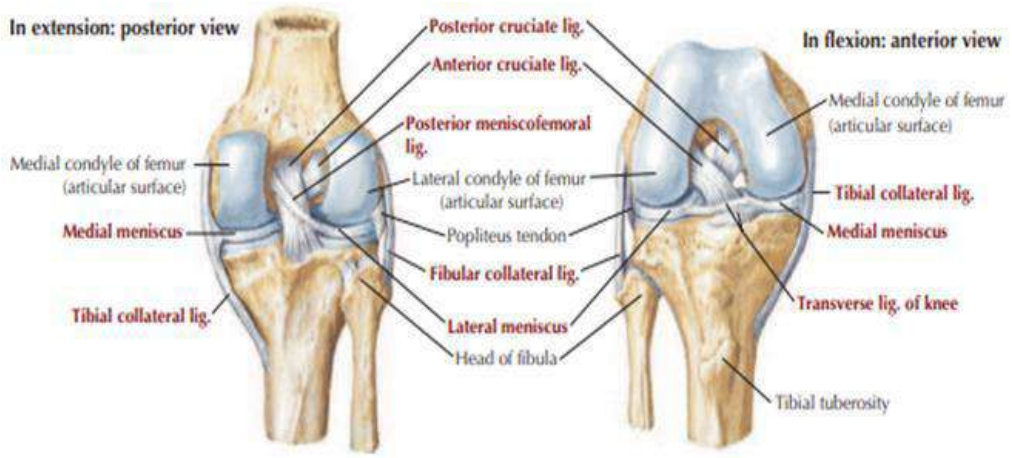
This triaxial knee joint is very often exposed to external and internal forces in more than five times the body weight. The normal range of knee movements is from 10° of hyperextension to 140° of flexion, 8°-12° of internal and external rotation. The distal femur condyles articulate with the proximal tibial articular surface throughout the knee range of motion.

The medial and lateral meniscus supports both articular surfaces and converts this non confirming geometry into a strong joint which is capable of bearing body weight.

The proximal tibia flares out from the shaft to form the lateral and medial tibial condyles. They form joint with the medial and lateral femoral condyles respectively.



PICTURE. 1: BONY STRUCTURES OF KNEE JOINT



PICTURE. 2: KNEE JOINT AND ITS LIGAMENTS

The articular surface of the proximal tibia is also sloped 7°-10° in an anterior to posterior direction and has a more surface area on the medial plateau compared to lateral tibial plateau. The interspinous insertion of the ACL is protected by medial and lateral tibial spines.

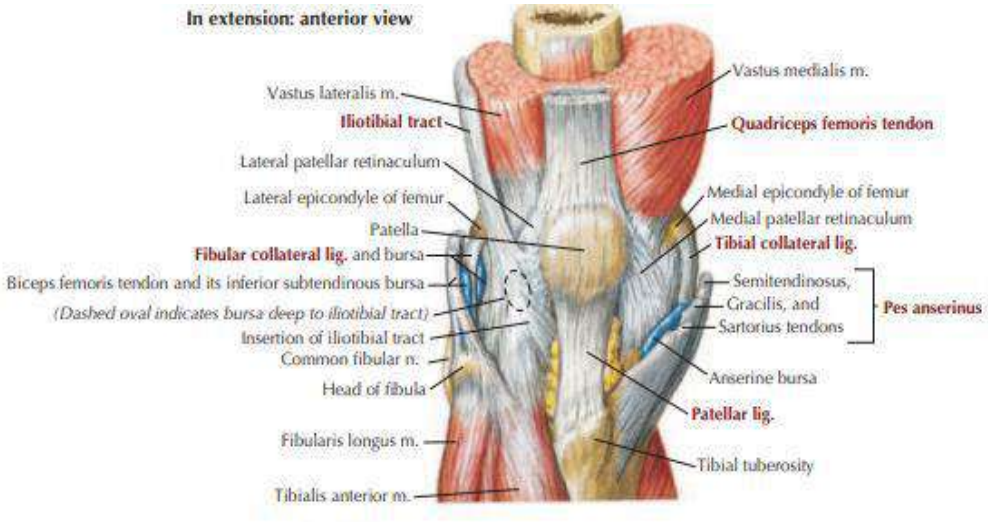
The rotation axis of tibia lies between the position of the mid portion of the tibia and the tibial tubercle (10°-15° of external rotation) [29, 30, 31].

MEDIAL CONDYLE OF TIBIA:

The medial condyle of tibia is comparatively larger than the lateral condyle of tibia. Bony articular surface of the tibia slope inferiorly approximately by 10 ° from anterior to posterior. Medial tibial condyle's superior surface articulates with the medial femoral condyle, the articular surface of medial tibial condyle is oval. The central part is slightly concave and comes into direct contact with the medial femoral condyle. The peripheral part of the articular surface is flat which is separated from the femoral condyle by the medial meniscus. The lateral margin of the articular surface is raised to cover the medial intercondylar surface. Medial tibial condyle is stronger than lateral tibial condyle because of this lateral condyle fractures are more common.

LATERAL CONDYLE OF TIBIA:

The lateral tibial plateau surface area is smaller and comparatively higher than the medial tibial plateau. Articular surface is convex from anteroposterior as well as from side to side. The fact that the lateral plateau is higher than the medial must be remembered during internal fixation, so that a screw inserted from lateral to medial does not enter the medial articulation. The convexity of the lateral plateau helps the surgeon to identify it on a lateral, particularly in the sagittal dimension, and more uniformly and gentle concave in both planes. Hyaline cartilage lines articular surface the medial tibial condyle and lateral tibial condyle. Fibula articulates with lateral tibial condyle through the facet for fibula to form a condylar joint. Fibular facet is flat, circular and directed downwards, backwards and laterally [29, 30, 31].



PICTURE 3: KNEE ANTERIOR VIEW

INTER CONDYLAR AREA:

The superior articular surface of tibia between the articular surfaces of the two condyles is roughened to form Inter condylar area.

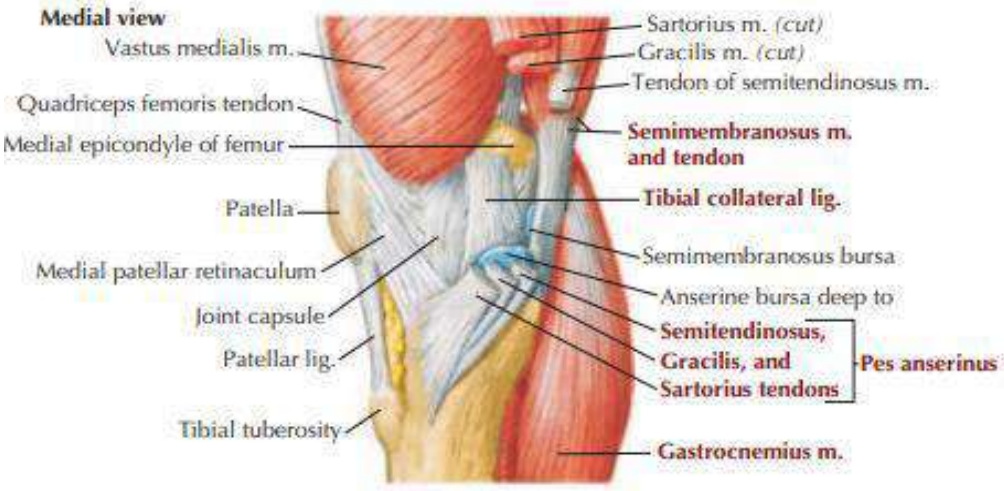
An elevation termed as “INTERCONDYLAR EMINENCE” is in the middle of the inter condylar region.

It gives attachment to the following structures from anterior to posterior direction.

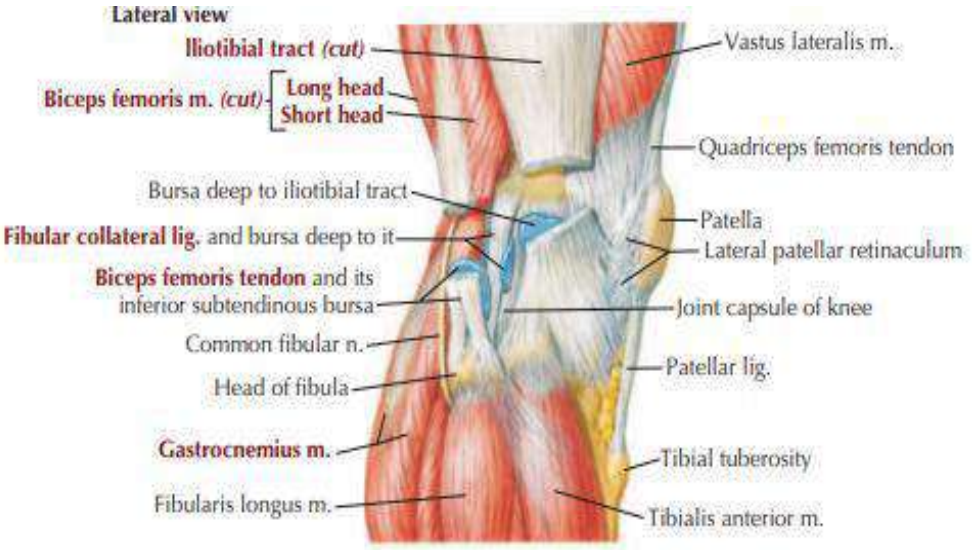
1) Anterior horn of the medial meniscus.
2) Anterior cruciate ligament (ACL)
3) Anterior horn of lateral meniscus
4) Posterior horn of the lateral meniscus.
5) Posterior horn of the medial meniscus.
6) Posterior cruciate ligament.

TUBEROSITY OF TIBIA:

Tuberosity of tibia lies at the upper end of the tibial shin. It has a smooth upper and a rough lower portion marked by a line or crest. Ligamentum patellae attaches to the upper smooth portion.



PICTURE 4: MEDIAL VIEW OF KNEE



PICTURE 5: LATERAL VIEW OF KNEE

LIGAMENTS OF KNEE JOINT:

Various ligaments supports knee joint.

1) FIBROUS CAPSULE:

The fibrous capsule is a thin structure and it is deficient on the femoral attachment site above the level of the patella. The capsule is attached to both femur and tibia about 1 cm beyond the articular margin. The capsule through CORONARY LIGAMENTS has weak attachment to the margins of both the menisci.

2) MEDIAL (TIBIAL) COLLATERAL LIGAMENT:

It is a flat, broad, triangular, membranous band attached above to the medial femoral epicondyle just below the adductor tubercle and attached distal to medial articular surface of the tibia.

Phylogenetically the degenerated tendon of the adductor Magnus is represented by tibial collateral ligament.

3) FIBULAR (LATERAL) COLLATERAL LIGAMENT:

Proximally attachment site of LCL is to the lateral epicondyle, below origin of the lateral head of gastrocnemius and above the insertion of the popliteus tendon; distally attachment site is to the fibular head which is overlapped by the biceps femoris tendon, and protected by bursa. It is separated from the capsule by the inferolateral genicular vessels and nerves.

4) OBLIQUE POPLITEAL LIGAMENT:

It is an expansion of fibrous tissue from the tendon of semimembranosus later blends with the fibrous capsule at the back of the knee joint. It ascends laterally and proximally to the intercondylar fossa. The popliteal artery overlies on the oblique popliteal ligament and it is penetrated by genicular vessels.

5) ARCUATE POPLITEAL LIGAMENT:

It is a 'Y' shaped ligament. It is a thickened band of the posterior capsular fibres. It stars from the fibular head, arches over the popliteus tendon, and is attached to the posterior border of the tibial intercondylar area.

6) CRUCIATE LIGAMENTS:

These are a pair of very strong ligaments connecting the tibia to the femur. Both cruciate ligaments lie within the knee joint capsule, but not within the synovial membrane. The anterior cruciate ligament is attached to the anterior aspect of the tibial articular surface between the attachments of the anterior horns of the medial and lateral menisci. The ligament ascends posterolaterally twisting on it and is attached to the posteromedial corner of the lateral condyle of femur. The posterior cruciate ligament is stronger, shorter and less oblique than the anterior cruciate ligament. It is attached to a smooth impression on the posterior part of the tibial intercondylar area, which extends to the upper

most part of the posterior surface of the tibia. The posterior cruciate ligament ascends anteromedially and is attached to the anterolateral aspect of the medial condyle of femur. Both cruciate ligaments cross each other like the limbs of the letter X, the anterior ligament lying mainly anterolateral to the posterior ligament.

7) THE MENISCI:

The menisci are crescentric laminae of mainly dense collagenous fibrous tissue that lie on and are attached to the tibial articular surface.

The medial mensicus is almost a semilunar and is broad posteriorly. The lateral meniscus is 'C' shaped and about 4/5th of a circle and with uniform width. Anterior horn of the lateral meniscus is attached in front of the intercondylar eminence of the tibia, behind the anterior cruciate ligament. The posterior horn of lateral meniscus is attached behind the eminence in front of the posterior horn of the medial meniscus. From the posterior convexity of the lateral meniscus, fibrous bands pass upwards and medially to the medial femoral condyle known as anterior and posterior meniscofemoral ligaments of Humphry and Wrisberg.

The lateral meniscus covers much larger surface of the tibial articular surface than does the medial. The menisci are attached to the periphery of the tibial plateau through meniscotibial ligaments.

These structures are important to identify when performing a submeniscial exposure to visualize the articular surface of the tibial plateau. They can be carefully incised in horizontal fashion in submeniscal exposure and must be repaired back to avoid producing an iatrogenic peripheral meniscal detachment.

8) TRANSVERSE LIGAMENT:

It is a variable band fibrous tissue that connects the anterior horn of the medial meniscus to the anterior convexity of the lateral meniscus.

9) SYNOVIAL MEMBRANE:

It is attached to the articular margins of the femur, tibia and patella and lines the deeper aspect of the capsule, but it is separated from the capsule by the popliteus muscle and the cruciate ligaments. Anteriorly, the synovial

membrane is separated from the patellar ligament by the infrapatellar pad of fat.

10) LIGAMENTUM PATELLAE:

This ligament is the condensation of the common tendinous portion of quadriceps femoris muscle; the remaining portions of the patellar tendon form medial and lateral patellar retinacula. Proximal attachment to the margin and posterior surface of the apex of patella and distal attatcment to the smooth part of tibial tuberosity. The superficial fibers pass in front of the patella. It is related to the superficial and deep infrapatellar bursae, and to the infrapatellar fat pad [29, 30, 31].

BLOOD SUPPLY TO KNEE JOINT:

The genicular circulation takes care of the blood supply for all structures of the knee joint. Five arteries form anastomosis around knee joint.

1) The superior genicular artery
2) The medial genicular artery
3) The middle genicular artery
4) The lateral inferior genicular artery
5) Anterior and Posterior recurrent arteries.

This anastomosis supplies bone, capsule and synovial membrane. This anastomosis is situated around the patella, the lower end of femur and upper end of tibia.

1. Superficial part: Lies in the superficial fascia around the patella and the ligamentum patellae
2. Deep part: Over the femur and tibia. It is formed [29,30, 31].

Medially by

1) Descending genicular artery
2) Superior medial genicular artery
3) Inferior medial genicular artery

Laterally by

1) Descending branch of lateral circumflex artery
2) Superior lateral genicular artery
3) Inferior lateral genicular artery

4) Anterior tibial recurrent artery

5) Posterior tibial recurrent artery

6) Circumflex fibular artery

Medial side and lateral side arteries are connected by long anastomosis which is interconnected by horizontal anastomoses connections just above and below the patella.

ANASTOMOSIS AROUND KNEE JOINT:

Formed by,

1) Descending genicular artery – A branch of femoral artery

2) Descending branch of lateral circumflex femoral artery

3) Lateral genicular artery – anastomosis connecting the above two arteries

4) Medial genicular artery

5) Lateral inferior genicular artery

6) Medial inferior genicular artery

7) Anterior tibial recurrent artery

8) Circumflex fibular branch of posterior tibial artery [29, 30, 31]

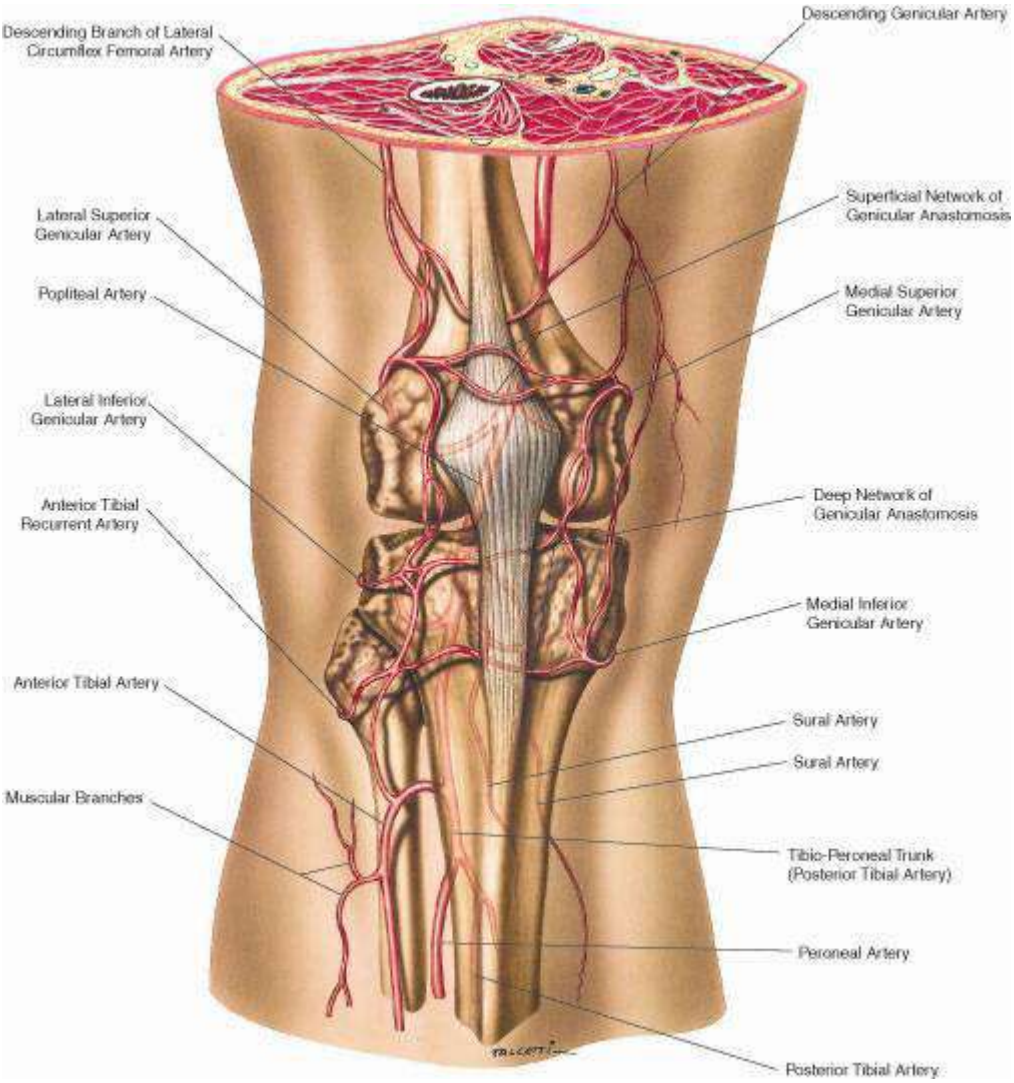
NERVE SUPPLY OF KNEE JOINT:

All three nerves supply the knee joint

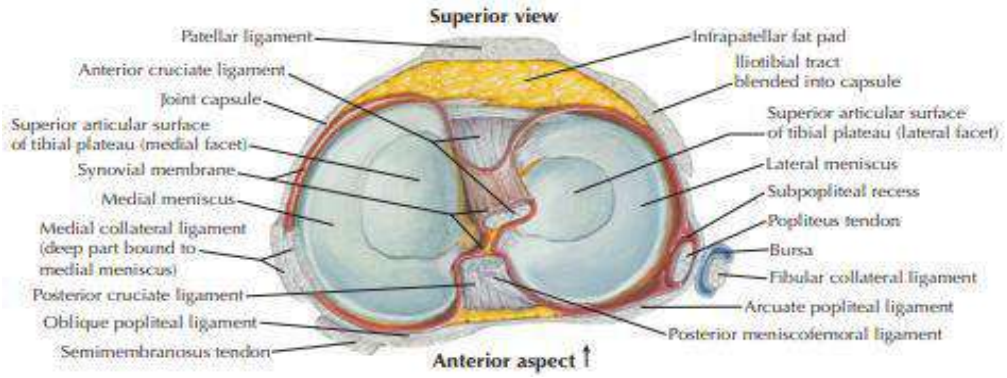
1) Nerve to vastus medialis branch of femoral nerve

2) Genicular branches of Sciatic nerve.

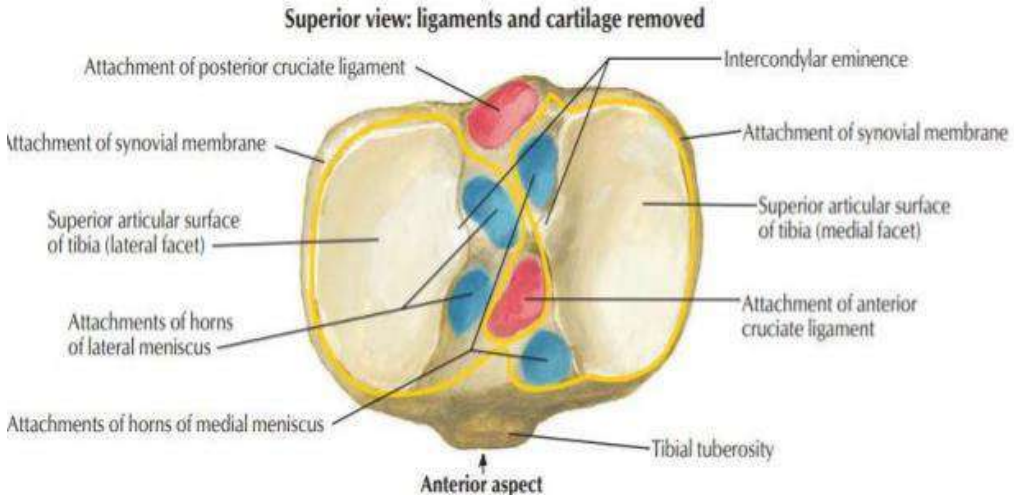
3) Posterior division of obturator nerve. [29, 30, 31]



PICTURE 6: ANASTOMOSIS AROUND KNEE JOINT.



PICTURE 7: SUPERIOR VIEW OF KNEE JOINT.


Superior view: ligaments and cartilage removed
Attachment of posterior cruciate ligament
Intercondylar eminence
Attachment of synovial membrane
Attachment of synovial membrane
Superior articular surface of tibia (lateral facet)
Superior articular surface of tibia (medial facet)
Attachments of horns of lateral meniscus
Attachment of anterior cruciate ligament
Attachments of horns of medial meniscus
Tibial tuberosity
Anterior aspect

PICTURE 8: KNEE JOINT SUPERIOR VIEW LIGAMENTS REMOVED.

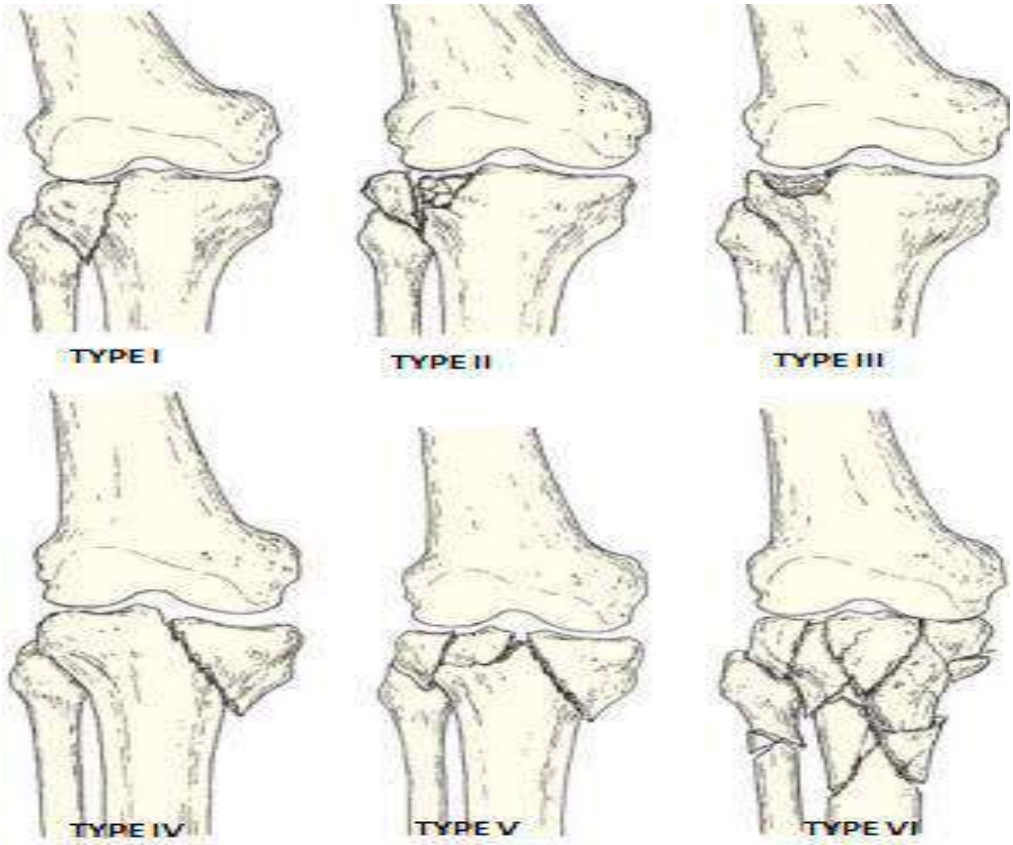
FRACTURE CLASSIFICATION:

A) SCHATZKER'S CLASSIFICATION [12]:

It is based on plain radiograph of the proximal tibia.

Totally six types.

1) Type I: Pure lateral tibial condyle split fracture
2) Type II: Lateral tibial condyle split with depression
3) Type III: Pure central depression
4) Type IV: Medial tibial condyle fracture
5) Type V: Both condyle fractures
6) Type VI: Both condyle fractures with metaphyseo diaphseal dissociation.



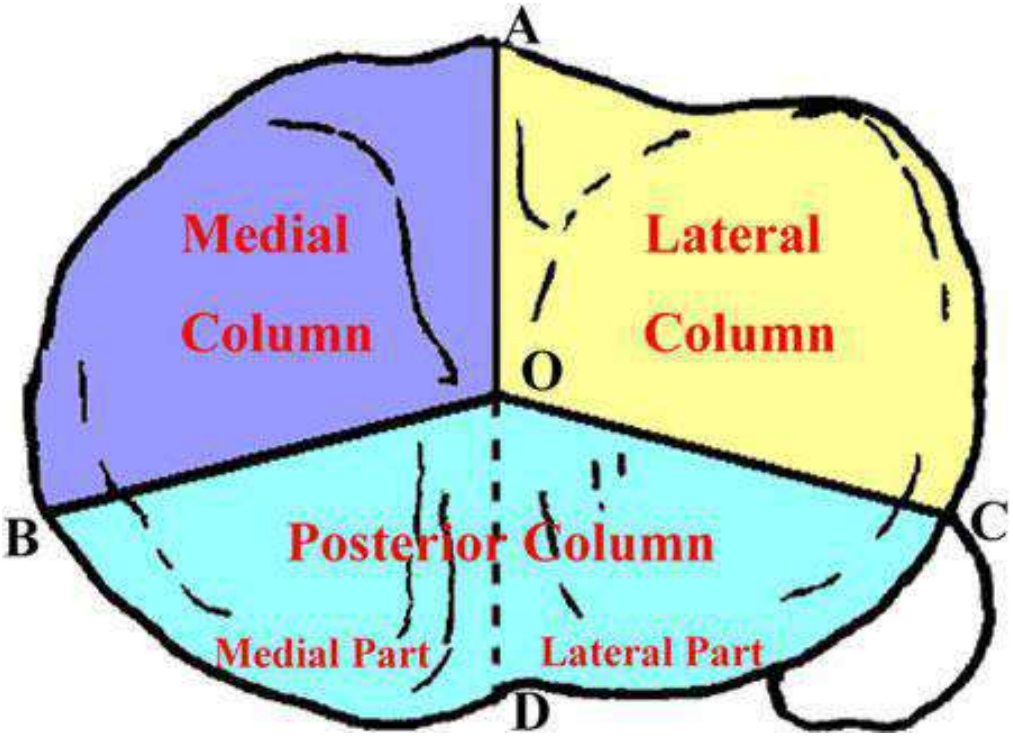
PICTURE 9: SCHATZKERS CLASSIFICATION.

B) THREE COLUMN CLASSIFICATION [32]:

Other classification systems are mainly based on antero posterior view of knee radiograph. So, they cannot discriminate the major fracture line running in coronal plane like posteromedial fragments.

Three column concept of proximal tibia fractures is a novel concept increasing the inter observer reliability regarding fracture classification also in proper preoperative planning also guides in choosing the proper approach for fixation in complex proximal tibial fractures and fractures with posterior communition.

Higgins et al in 1988 identified 59% posteromedial fragments in Bicondylar tibial plateau fractures. So, Luo et al in 2010 devised a three column concept classification based axial CT and three dimensional CT. In this classification, tibial plateau is divided into three columns namely medial column, lateral column and posterior column. Advantage of this system is it identifies the posteromedial fracture fragment which needs posteromedial approach and buttressing. Due to ease and simplicity of this classification, interobserver reliability is good



PICTURE 10: THREE COLUMN CLASSIFICATION.

- Zero column -schatzker type III

As per three column concept there should be a break in one cortex to classify it as a single column. So, only depression is considered as zero column

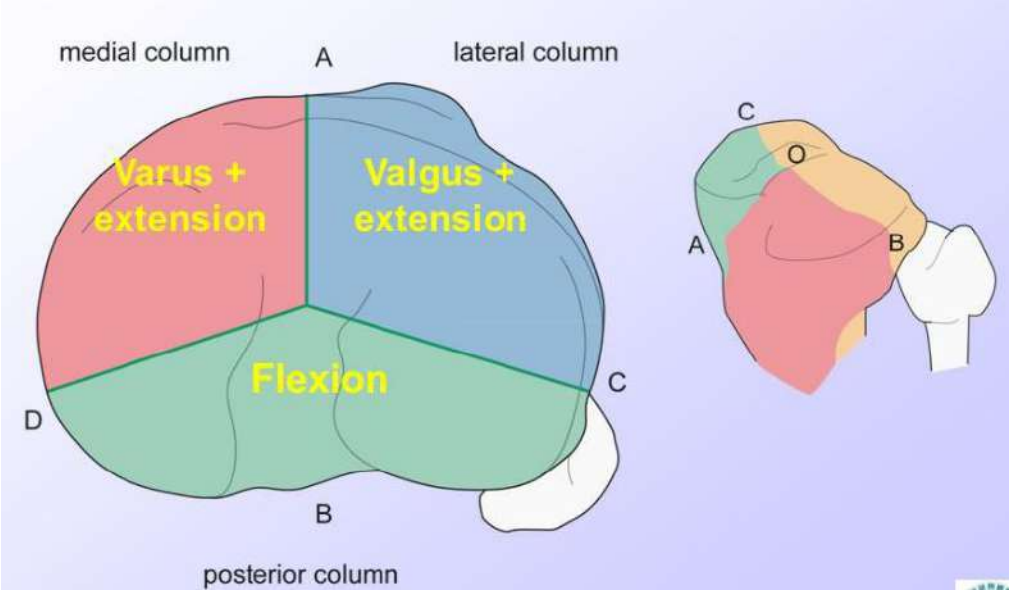
- One column - schatzker type I and II

Articular depression in the posterior column with a break of the posterior wall is also defined as a one-column. Posterior column fracture -this type of fracture is not included in any type of the Schatzker classification. Consideration of posterior column is very vital because lack of fixation of posterior communition will lead to varus collapse in the post-operative period

- Two column - schatzker type IV

Usually medial column associated with posteromedial fragment.

- Three column - schatzker type V and VI At least one independent articular fragment should be there in each column.



PICTURE 11: MORPHOLOGY AND INJURY MECH

Treatment / Management

Restoration of the axial and rotational alignment of the limb and knee stability is the most essential factors for successful functional outcomes of tibial plateau fractures. Anatomical reduction and restoration of articular congruity are critical but less important for functional outcomes. Soft tissue management is an additional significant factor. Until the fracture is stable, the initial treatment entails preventing further soft tissue injury. This is possible by knee immobilisation and cryotherapy [5, 17, 25]

Non-Operative Management

Nonsurgical treatment is an alternative for some fractures and clinical situations. In hinged bracing, immediate passive range of motion with non-weight bearing for 6 to 12 weeks is currently preferred because it allows for mobility while maintaining coronal support. Indications for nonsurgical treatment include undisplaced or minimally displaced fractures, less than 5° of varus/valgus instability, delayed presentation, significant medical comorbidities preventing patients from undergoing surgery, non ambulatory patients, and elderly patients with low functional status who can tolerate deformities. The potential to anticipate the probability of post-treatment deformity, malalignment, and instability is essential for selecting patients for nonsurgical treatment. Angular misalignment is not well tolerated by patients and will result in cosmetic difficulties, articular cartilage overload, and an

increased possibility of knee instability, all of which can lead patients to be unbalanced and increase their risk of falling. The patient's demographics, activity level, comorbidities, and limb alignment can be used to estimate the risk for instability. Bone quality, fracture type, condylar width, the degree of articular depression, and the extent of fracture comminution are useful imaging measures for determining the likelihood of instability [5, 17, 25].

Considering the fracture pattern can aid in decision-making. Larger lateral split depression fractures and all medial plateau fractures have a considerably greater tendency to collapse into valgus and varus deformities, respectively, although smaller fragment Schatzker II fractures may be responsive to nonsurgical treatment. Almost all unicondylar medial tibial plateau fractures with displacement and bicondylar fractures with displacement should be surgically treated [33].

Commonly, surgical therapy is used to ensure precise limb alignment, promote early mobility, and achieve a better reduction. Despite articular incongruities and displacements, the practitioner should remember that nonsurgical treatments can achieve great outcomes for patients who are unable or reluctant to undergo surgery. [34]

Operative Management

Surgical treatment is indicated for tibial plateau fractures in which near-anatomic alignment cannot be accomplished reliably based on fracture pattern, physical exam findings, and radiological data. Bicondylar plateau fractures and shaft dissociation patterns are fracture types that demand operative therapy in young, active patients without comorbidities. In addition, the majority of medial and lateral plateau fractures necessitate surgical treatment, unless they are slightly displaced and correct tibial/knee alignment can be achieved without fixing.

The degree of articular depression is another possible indication for surgical intervention. This indicator is more heavily discussed, and several cutoffs are found in the literature. >2.5 to >10 mm are the cutoffs for articular depression that, if left untreated, result in poor results [33-40]. Unfortunately, the precision and dependability of assessing articular depression are debatable. Martin et al [41]. Discovered that 10% of the time, independent observers makes articular depression assessments that disagree by 12 mm or more. Greater articular

depression than a predetermined threshold should not be the main criterion for deciding whether or not to perform surgery.

Poor functional outcomes and a high frequency of meniscal pathology have prompted numerous authors to recommend condylar width increases of >5 mm and varus/valgus instability of >5° as surgical indications [33, 36, 42]. Wang et al [44]. Could not predict soft tissue injury based on tibial plateau expansion. Johannsen et al [45]. propose that differences in the literature on condylar widening can be addressed by utilising a ratio of the articular widths of the femur and tibia in order to eliminate difficulties with magnification and calibration in measurements.

In aged, inactive, or less active individuals, as well as those with comorbidities that increase surgical risk, the decision to proceed with operative management must be evaluated with greater care. Each patient's risk-benefit analysis must be weighed in order to choose the most appropriate treatment. If their functional needs are lower, elderly and inactive individuals will be less affected by slight deformities.

Various surgical techniques used are explained below:

Open reduction and internal fixaion (ORIF): [17] This is suitable for fractures of the tibial plateau with considerable articular step-off, condylar widening, ligamentous instability, and Schatzer IV, V, and VI injuries.

Based on the fracture pattern, the treatment method is modified. Commonly, a lateral approach with a straight or hockey stick-shaped anterolateral incision is used. For medial plateau fractures and those with posteromedial extensions, a posteromedial incision using the space between the pes anserinus and the medial head of the gastrocnemius has been described. Dual surgical incision medial and lateral is appropriate for bicondylar fractures. For posterior shearing fractures, posterior methods are reserved.

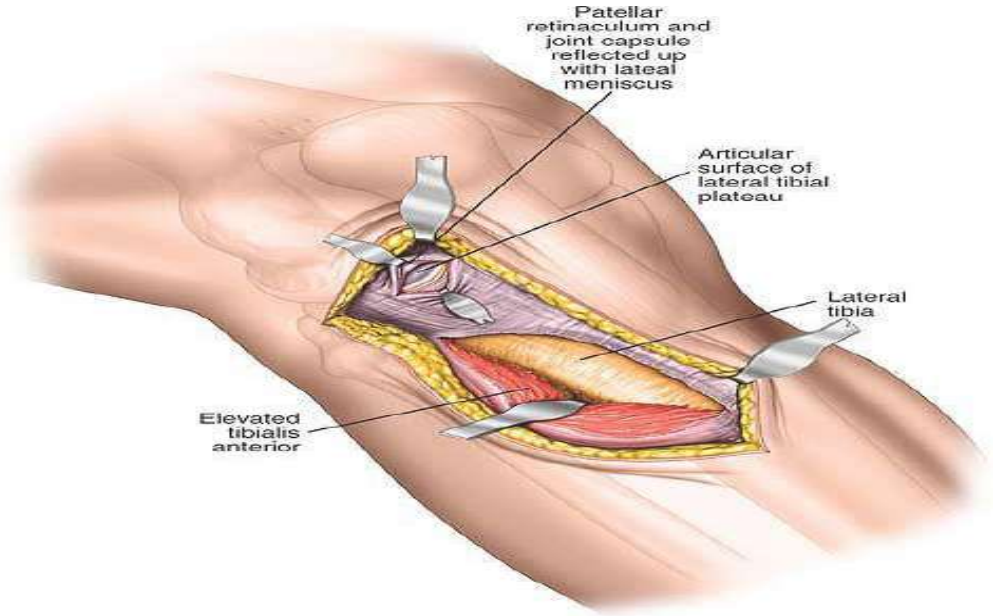
SURGICAL APPROACHES:

Two approaches commonly used in ORIF of tibial plateau fractures,
namely

- Anterolateral approach
- Posteromedial approach [46]

Anterolateral approach:

This is the commonly used approach to surgically treat lateral column fractures. Split depression or pure depression type of the lateral tibial condyle fractures was reduced by this approach. Proximally the incision is started from the Gerdy's tubercle and is extended distally over the anterior compartment along the tibial shin. Usually inverted L-shaped incision made over the tibial shin provides adequate access to the anterolateral surface of the tibia. While dissecting over the posterolateral border of the tibia maximum care to be taken to avoid the anterior tibial artery injury which usually passes through the interosseous space.


Patellar retinaculum and joint capsule reflected up with lateal meniscus
Articular surface of lateral tibial plateau
Lateral tibia
Elevated tibialis anterior

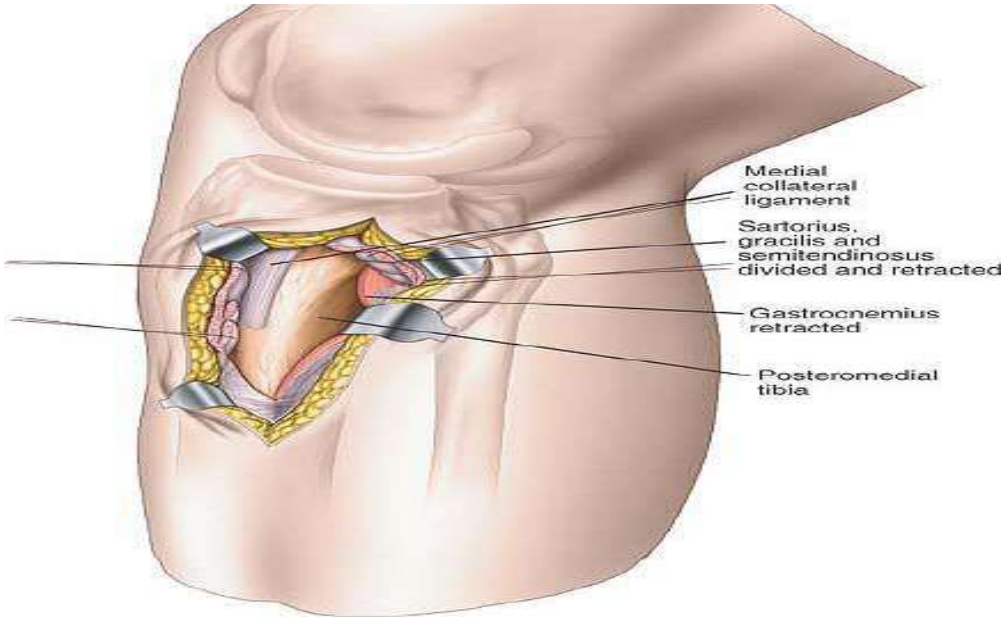
PICTURE 12: ANTEROLATERAL APPROACH.

Posteromedial approach:

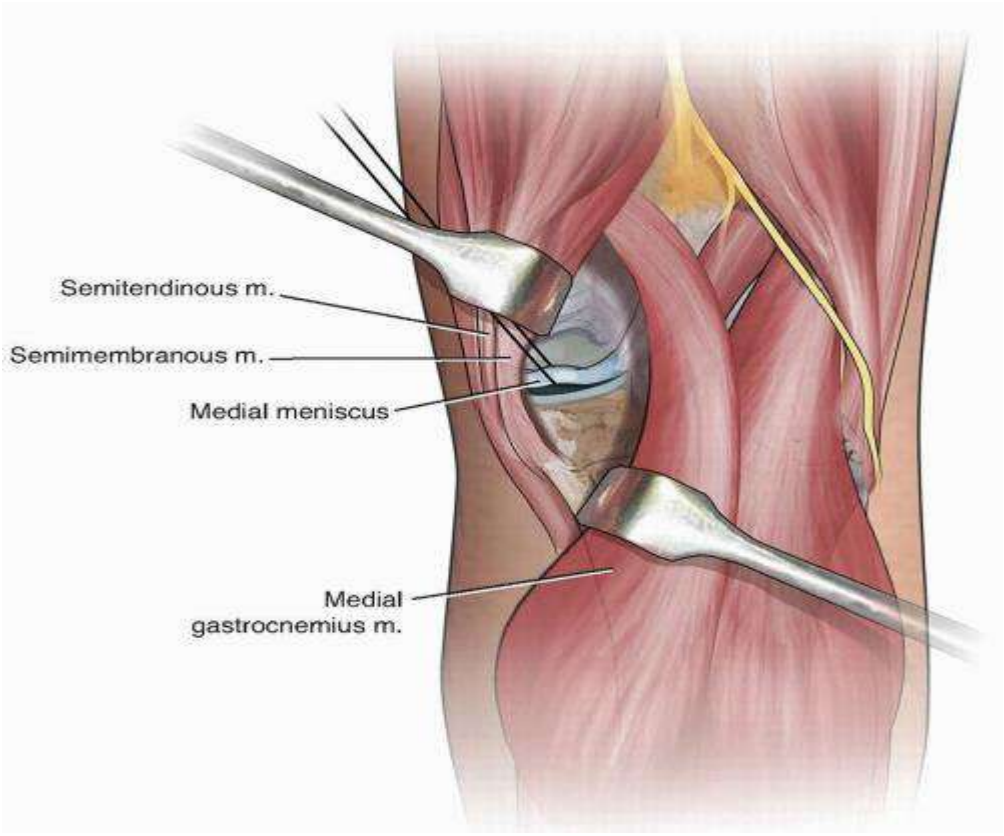
The posteromedial approach is used for open reduction

and fixation of the fracture on the posterior column and medial column of the proximal tibia mainly for the posteromedial fragment. This approach has a advantage with regard to soft tissue injury that it has got relatively adequate soft tissue cover and it is far away from the anterolateral approach allowing these two approaches to be easily combined when necessary to reduce soft tissue complications.

Posteromedial plating is helpful to buttress the posteromedial fragment. An anti-glide plate is a form of buttress plate which is placed over the fracture to prevent it from gliding due to the forces acting on it. Patient usually kept in supine position so that it allows access to the front of the knee for a second anterolateral approach. The leg is externally rotated to access posteromedial region and internally rotated to access anterolateral region.



PICTURE 13: POSTEROMEDIAL APPROACH.



PICTURE 14: POSTEROMEDIAL APPROACH IN PRONE POSITION.

Alternatively, prone position of the patient can be used to access posteromedial region but in this position we cannot access the anterolateral region. Otherwise we can make the patient floppy lateral position a position which is midway between lateral and pronen position, internal rotation allows posteromedial approach and external rotation of leg allows anterolateral approach. Care must be taken to avoid saphenous nerve and vein during subcutaneous dissection. The deep plane of this approach is between the posterior aspect of the pes anserinus tendons and the medial head of gastrocnemius. A retractor which is used to protect the popliteal fossa structures should be placed underneath the medial head of gastronemius. Splitting the medial head of gastronemius further increases the exposure in the posteromedial approach. Popliteus muscle origin also sometimes erased and retracted laterally which increases the visualization of the fracture. [46]

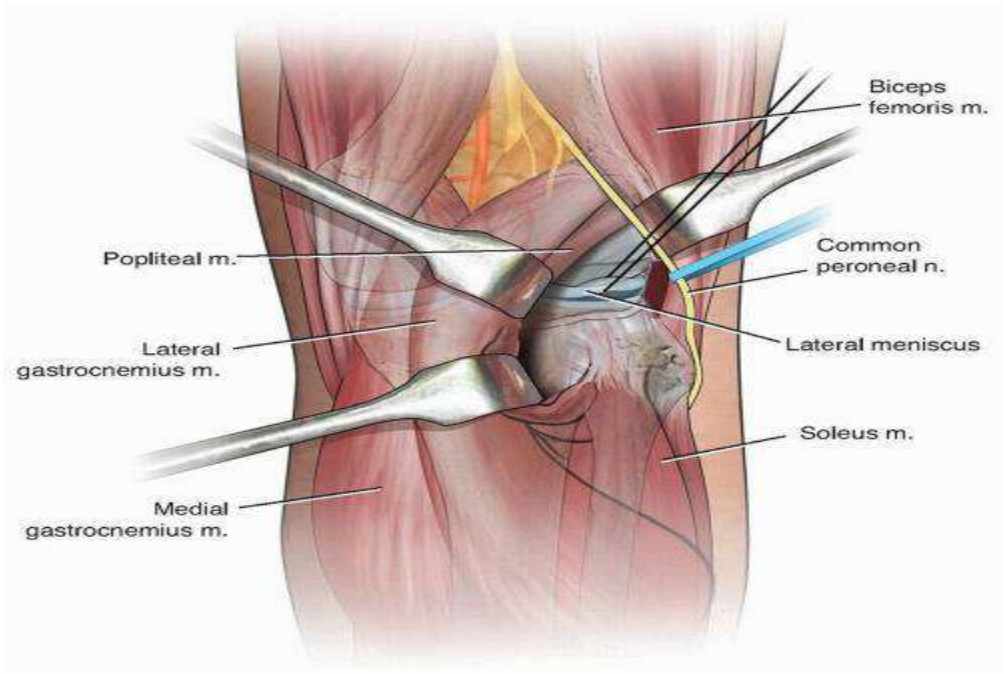
Anteromedial approach:

The anteromedial aspect of tibial plateau is easily accessed through similar to an approach used for total knee arthroplasty. But, it is highly unusual for

fracture patterns to involve the anteromedial tibia in alone. Medial column fracture patterns often involve the posteromedial plateau, which requires a posteromedial approach. Occasionally through the same skin incision, a separate anteromedial interval can be made in front of or between the pes anserinus tendons to reduce and fix through posteromedial approach.

Posterlateral approach:

If we encounter posterolateral comminution which is difficult to stabilize from an anterolateral approach, this approach can be used. If the posterior plateau is comminuted on the far lateral side, it cannot be stabilized through the posteromedial approach. So, a posterolateral approach which has a plane between the biceps femoris and the lateral head of gastrocnemius is needed to access the posterolateral column. Mobilization of the personal nerve is a must to increase access and to protect the nerve from injury.



PICTURE 15: POSTEROLATERAL APPROACH.

DUAL PLATE TECHNIQUES

Surgical treatment for high-energy displaced bicondylar fractures of the tibia plateau remains a challenge for most surgeons. According to the Schatzker classification, types V and VI are complex fractures often associated with soft tissue injury, a high risk of wound complications, difficulty in reduction, and further sufficient fixation for stabilization. However, the ideal fixation method is not yet clear, and treatment options include screws, an external fixator, hybrid

external fixation, limited internal fixation combined with a tensioned wire, classic dual buttress plates, a unilateral periarticular locking plate, and hybrid dual plates (combination of locking plate and buttress plate) [47-49].

The controversy of surgical vs conservative management for high velocity tibial plateau fractures is overcome by enlightening the goals for operative management which are anatomic reduction, restoration of articular congruity and alignment, stable fixation to allow early knee motion [50].

Among wide spectrum of operative management, Dual plating via two incisions is preferred technique as it has its own advantages when compared to other modalities of treatment such as Isolated Lateral locking plate, Hybrid external fixator, Ilizarov, LISS.

Single plating for these fractures has associated with postoperative malreduction rate of 15-23%, which will lead to long-term disability. Biomechanical cadaveric studies have demonstrated that dual plate fixation of these fractures allows less subsidence and loss of alignment as compared to single plate fixation. Presence of posteromedial fragment in 33% of these fractures based on CT scan requires posteromedial buttressing, hence dual plating is recommended. Various studies have suggested that single midline incision has high complication rates in the form of wound healing and sepsis. This led to development of two-incision approach which allows for addressing the posteromedial and posterolateral fracture precisely and minimizing the wound complication rate [51-53].

Dual plate fixation using locking or buttress plate through two-incision approach allows for anatomic joint reduction, adequate fixation, maintenance of alignment, and early rehabilitation to achieve better functional outcome. The advantages of dual plating over other types of fixations include-Coronal split of the medial condyle can be fixed separately with posterior-medial plate, better reconstruction of articular surfaces, better distribution of forces along the axis of the bone, better load sharing capability with dual plates compared to single lateral plate alone. Dual plates resist displacement, medial condyle collapse and allow early mobilization of the knee joint [50, 51, 53, 54].

Purpose of this prospective study was to evaluate the clinical and radiological outcomes of dual plating technique for treating type VI tibial plateau fracture.

Other treatement modalities-

Similar to open reduction and internal fixation, arthroscopically aided reduction and internal fixation can produce similarly good results in particular Schatzker I to III fractures [55, 56].

Primary Total Knee Arthroplasty: This may be a viable alternative for certain patients with particular fracture patterns.

Differential Diagnosis for Proximal tibia fractures-

Common symptoms of tibial plateau fractures include knee deformity and effusion. It is crucial to evaluate for additional probable intra-articular fractures, such as distal femur and tibial spine fractures. Plain radiographs and CT scans are used to diagnose fractures of the tibial plateau. Consider the possibility of additional soft tissue injuries to the medial and lateral meniscus, ACL, and collateral ligaments [57].

Prognosis of Proximal tibia fractures-

Numerous studies have demonstrated that after open reduction and internal fixation of any form of tibial plateau fracture, functional results are diminished. On plain radiographs, the presence of post-traumatic knee arthritis did not correlate with functional result. Studies have indicated that high-energy trauma mechanisms are related with negative consequences [58]. Restoration of joint stability is the most significant element influencing long-term outcomes. External fixation of substantially comminuted fractures in older patients is associated with a high nonunion rate and indications for delayed arthroplasty. The worst long-term outcomes were observed when there was accompanied ligamentous instability, meniscectomy, or more than a 5 degree change in the mechanical axis of the limb.

Complications of Proximal Tibia fractures-

Postoperative infections have been linked to male gender, smoking, lung illnesses, bicondylar features, and prolonged intraoperative duration. Compartment syndrome can be a catastrophic consequence, and the treating physician should be highly suspicious of its presence.

Long-term consequences of tibial plateau fractures can impair quality of life [58-61]. For patients whose jobs involve a high degree of movement, a tibial plateau fracture may severely delay return to employment [62]. These consist of the following:

- Abnormal gait.
- This has been linked to meniscectomy, axial malalignment, septic arthritis, and ligamentous instability.
- Post-traumatic osteoarthritis of the ankle is caused by an irregular gait.
- Chronic pain.

EARLY COMPLICATIONS:

- Hemarthrosis
- Wound infection /Dehiscence - Superficial or Deep
- Sepsis
- Compartment syndrome
- Knee stiffness
- Nerve Injury (Common peroneal nerve involved commonly)
- Vascular Injury (Anterior tibial artery involved commonly)
- Limb length discrepancy
- Deep vein thrombosis

LATE COMPLICATIONS:

- Wound Infection
- Knee stiffness
- Malunion
- Knee instability – varus/valgus/anterior/posterior
- Extensor lag
- Angular deformities
- Persisting pain/swelling
- Delayed union
- Non-union

STUDIES PERTAINING TO THE STUDY

David P. Barei et al [63] **(2006)**conducted a retrospective study to evaluate the perioperative results and functional outcomes of medial and lateral plate stabilization through anterolateral and posteromedial surgical approaches of comminuted bicondylar tibia plateau fracture over a seventy seven month period in which bicondylar tibia plateau fractures were treated with medial plate and lateral plate through two exposures(anterolateral and

posteromedial), in which mean duration of follow up was of fifty nine months. Using MFA (musculoskeletal function assessment function) questionnaire to evaluate functional outcome and immediate biplanar postoperative radiographs to evaluate the quality of reduction. They concluded that medial and lateral plate stabilization of comminuted bicondylar tibia plateau fractures through medial and lateral surgical approaches is a useful treatment method; however, residual dysfunction is common. Accurate articular reduction was possible in about half of patients and was associated with better outcomes within the confines of the injury severity.

Thomas F. Higgins et al [64] **(2007)** conducted a designed study to test the comparative strength of lateral-only locked plating to medial and lateral non locked plating in a cadaveric model of a bicondylar proximal tibia plateau fracture in which ten matched pairs of human cadaveric proximal tibia specimens were used for biomechanical testing. Cyclic loading using a materials testing device simulated initial range of motion and load bearing following surgical repair. Subsidence of the medial and the lateral condyles was measured following 10,000 cycles from 100N to 1,000N; the maximum load to failure on the medial condyle for both plate constructs was also measured. On the lateral side, dual plating (DP) allowed an average of 0.68 plus minus 0.14 mm of subsidence, compared with 1.03 plus minus 0.27 mm for the ed-angle plate fix. On the medial side, DP allowed an average of 0.78 plus minus 0.15 mm of subsidence, compared with 1.51 plus minus 0.32 mm for the fixed angle plate. The results of this study demonstrate that dual-plate fixation allows less subsidence in this bicondylar tibia plateau cadaveric model when compared to isolated locked lateral plates.

Kye-Youl Cho et al [65] **(2013)**conducted a study on ten patient who are being followed after a treatment of schatzker type v and vi tibia plateau fractures with a midline longitudinal incision and dual plating. Clinical outcomes evaluated using range of motion, visual analogue scale and radiological outcome using bony union time, medial proximal tibial angle and posterior proximal tibial angle. They concluded that schatzker type V and VI tibia plateau fractures with a midline longitudinal incision and dual plating resulted in satisfactory clinical and radiological outcomes.

Prasad et al. (2013) [66] evaluated the functional success of lateral and medial plate fixation of Schatzker type V and VI fractures by anterolateral, medial minimally invasive, or posteromedial approaches. Over 8 years, they treated 46 Schatzker type V and VI tibial plateau fractures with lateral and medial plates. All patients required two-plane radiographs. Immediate postoperative radiography assessed reduction and fixation. Follow-up evaluation using the Oxford Knee Score. The study included 40 patients (33 males and 7 women) who completed follow-up. Schatzker type V and VI fractures totaled 40. Follow-up averaged 4 years (range 1-8 years). All patients underwent adequate articular reduction, defined as<= 2 mm step-off or gap. On supine AP and lateral knee X-rays; all patients had satisfactory coronal and sagittal plane alignment and articular breadth. Functional result, as judged by the Oxford Knee Score, was excellent in 30 patients and good in 10. All patients resumed pre-injury activity and employment. No deep infection. Dual plate fixation of severe bicondylar tibial plateau fractures allows early knee mobilisation. Minimizing soft tissue issues requires careful management and minimally invasive procedures.

Lee et al. (2014) [67] analysed the surgical results of unilateral locking plates, conventional dual plates, and hybrid dual plates for TPF in 45 patients with Schatzker types V and VI. 15 patients in group I were treated with a unilateral locking plate, designed by visiting staff. Group II patients received traditional dual plates. Group III patients were treated with hybrid dual plates (one lateral approach locking compression plate (LCP) Plus medial anti-gliding plate). All patients had 6-weekly F/Us for 18 months after surgery. 13 instances in group I achieved firm bone union without traumatic OA change, ROM restriction, or malalignment. 15 and 10 patients in groups II and III met the goal. Schatzker classification, operation time, phased therapy, inpatient period, and hardware impingement had significant differences. They found no statistical difference in union rates between these three groups. Clinical follow-up highlighted several significant points: Soft tissue concerns should be considered, and locking plates can reduce hardware impingement discomfort. Single lateral approach TPF with locking plate reduces operation time and hospitalization. If the medial buttress can not be produced by reducing the lateral fracture, open medial reduction is necessary to buttress the medial fragment with twin plates.

Michael R. Ruffolo Et Al (2015) [68] conducted a retrospective study to characterize the rate of complications after operative fixation of bicondylar (OTA/AO 41-C) tibia plateau fractures and to evaluate the contribution of common risk factors in which one hundred thirty-eight patients older than 18 years with 140 bicondylar tibia plateau fractures participated in study who underwent open reduction and internal fixation using medial and lateral plate construct through 2 incisions in which the overall major complication rate was 27.9%: 23.6% deep infection and 10.0% nonunion. Open fractures were associated with a higher rate of infection, definitive fixation was associated with significantly fewer deep infections 43.8% versus 21.0% for closed injuries. Fasciotomy closure before compared with internal fixation with open fasciotomy wounds: 11.8% versus 50.0%.The presence of compartment syndrome, tobacco use, diabetes, and timing of surgery had no statistically significant association on the rate of infection or nonunion. They concluded that nonunion and deep infections occur commonly after staged open reduction and internal fixation of high-energy tibia plateau fractures.Open fractures and open fasciotomy wounds at the time of internal fixation are associated with higher rates of infection.

In 2016, Patel et al [69] conducted a study to investigate the efficacy of dual locking plate and buttress plating in the minimally invasive treatment of proximal Tibial Schatzker V and VI tibial plateau fractures. This study was conducted on 30 patients with Tibial plateau fractures (Schatzker classification types 5 and 6) who were treated with minimally invasive bicondylar fixation and admitted to the department of orthopaedics at Unique super speciality centre, Indore. The patients were followed for a minimum of six months, and the knee society score was used to evaluate the clinical and radiographic advancement of fracture union and the functional result. Two out of thirty patients were lost to follow-up, and twenty patients had outstanding outcomes, while eight had good to fair outcomes and none had bad outcomes. The average time required for radiological union was twelve weeks. they concluded that Bicondylar fracture fixation employing a minimally invasive approach yielded outstanding results and no severe complications, according to the study's findings.

Manjunath et al. in 2019 [70] to evaluate the clinical and functional result of surgically repaired Bicondylar Tibial schatzker type V and VI plateau fractures with dual plating at the SSIMS-RC, Davanagere between August 2015 and August 2018. The investigation included all skeletally mature individuals with proximal tibia fractures Schatzker types V and VI (>18 years), AO Muller types 41-C1, 41-C2, 41-C3, and Gustilo-Anderson types I and II. Utilizing the Honkonen Jarvinen Criteria for radiological, functional, and clinical outcome, the results of this study ranged from outstanding to good. According to this study, the clinical outcome for Honkonen Jarvinen was 86% excellent, 11.7% good, and 1.5% poor. 81% of the functional outcome was rated as excellent, 13% as good, 5% as fair, and 1% as poor. The radiological results were 79.2% excellent, 12.0% good, and 0.80% poor. They came to the conclusion that surgical care of bicondylar tibial plateau fractures with dual plating provides excellent anatomic reduction, correct axial and articular alignment, rigid internal fixation by dual locking plate, and a stable and functional knee joint.

Caner Citak et al [71] **(2019)** conducted a study from 2010 to 2015 on patients who underwent surgical treatment due to bicondylar tibia plateau fracture in which they divided 10 patients each in two groups, one group was employed for dual locking plating system and in the other group for only lateral locking plate . In both the groups, clinical and radiological outcome were rated according to Rasmussen functional score and Rasmussen radiological score. They concluded that in bicondylar tibia plateau fracture without posteromedial fragment, the lateral locking plate fixation technique showed the similar clinical and radiological outcome as dual plate fixation technique.

YASH PARIKH et al [72] conducted a prospective study from from From April 2017 to June 2019 included 30 cases of closed proximal tibia classified as Schatzker type v and vi fractures(bicondylar tibia plateau fractures) managed by dual plating.Patients were followed up at 2^{nd} , 6^{th} , 12^{th} and 24^{th} postoperative weeks.Average Oxford Score was used and concluded that open reduction and internal fixation using dual plates is an excellent method of treatement of closed bicondylar tibial plateau schatzker type V and VI.

Raj et al. (2021) [73] examined the functional outcomes and consequences of dual plating for bicondylar tibial plateau fractures. 30 patients with bicondylar

tibial plateau fractures were treated with dual plating from January 2017 to August 2019. 5 patients had type (V) bicondylar tibial plateau fracture and 25 had type (VI). All fractures healed in 18 weeks. The typical knee range of motion was 1.5°-130° (0°-10° for extension lag, 100°-135° for flexion). Rasmussen's final functional grade was 26.75. Rasmussen's radiological evaluation gave all patients an excellent or good score of 8.5. (Range 6-10). Post-operative radiographs showed MPTA of 84.3° and PPTA of 6.2°. Five people in this research had issues. No subsequent reduction loss, implant failure, malunion, or non-union occurred. They concluded that surgical treatment of bicondylar tibial plateau fractures with dual locking affords rigid fixation with satisfactory functional and radiographic outcomes.

MATERIALS AND METHODS

This is a study of radiological and functional outcome in proximal tibia fractures managed with dual plating using Modified Radiological Rasmussen Score for radiological assessment and Modified Clinical Rasmussen Score for clinical assessment conducted in the department of orthopedics at Dayanand Medical College and Hospital from 1st June 2019 till 31st march 2022 after getting clearance from hospital ethical committee. During above mentioned period 37 patients were treated for tibial plateau fractures by internal fixation.

All the required data for the study was collected from the patients after getting their appropriate consent during their stay in the hospital, during follow up at regular intervals and from the medical records.

INCLUSION CRITERIA

- Patient in age group above 18 years
- Patients giving consent to participate in study
- Closed and open fracture schatzker`s type v and vi
- Follow up to 6 months duration

EXCLUSION CRITERIA

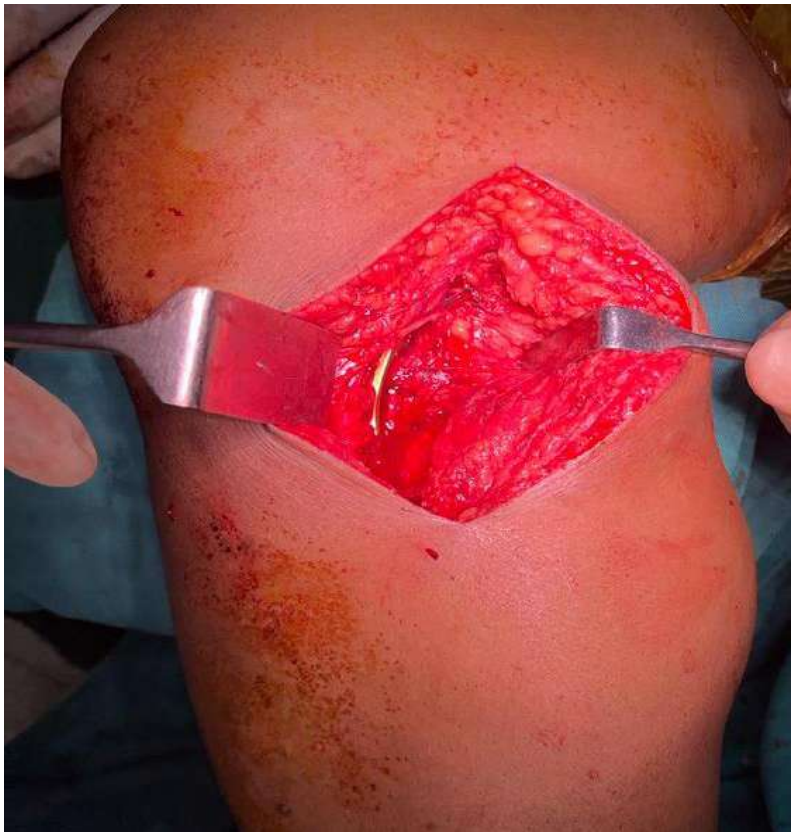
- Patients in age group 18 years and above
- Patients who refused to give consent
- Patients failing to follow up
- Patients with vascular injury

Management

Patients were first seen in the emergency trauma ward. The history was taken followed by clinical examination of the patient. If there is any associated system injuries, concerned specialists undertook appropriate management. Intensive monitoring and care was given to those patients who presented with shock and immediate resuscitative measures were undertaken. Once the patient's general condition was stable, relevant X-rays and CT scan done if required. The treatment method was decided after classifying the type of fracture, the displacement and the amount of depression of the tibial plateau.

The patients were taken for surgery as early as possible time depending on their comorbidities and skin condition. All surgeries were done under image intensifier control. Fractures were fixed by open reduction and internal fixation. In our study dual plating has been done by two approaches being described as:

Medial plate through direct medial or posteromedial approach & Lateral plate through anterolateral approach



PICTURE 16: INTRAOPERATIVE PICTURE OF POSTEROMEDIAL APPROACH

Synthetic bone graft substitute were used in depressed and comminuted fractures. Postoperatively patients treated with above knee immobiliser for immobilization for 2 weeks. The sutures were removed on the thirteenth postoperative day. 5 days of intravenous antibiotics and 8 days of oral antibiotics were given. The patients were encouraged to do static quadriceps exercises for initial 3 weeks followed by passive knee range of Motion and

non-weight bearing crutch walking using unaffected limb up to 6 weeks after 2-3 weeks knee mobilization and assisted weight bearing crutch walking. An immediate postoperative X-ray was also done and later on follow up Xray repeated at 4 weeks, 6 weeks, 3 months and 6 months.

Follow up:

The first follow up was done at 2 weeks, during that time the surgical scar was examined for any discharge or tenderness and range of movements noted. The second follow up done at 4 weeks to look for any discharge, swelling, range of motion noted, X-ray taken to look for any loss of reduction. The third follow up done at 6 weeks during which a repeat X-ray was taken to look for fracture union or loss of reduction and range of motion noted. The third follow up was done at 3 months post operatively during which one more repeat X-ray was done and a clinical evaluation of union also done. Patients were allowed for partial weight bearing and gradually progressed to full weight bearing based on the clinical and radiological signs of union. The patients were asked to come for follow up at 6 months. For every follow up of the patients on 4 weeks and 6 months post operatively, clinical assessment done by Modified Rasmussen Score and radiological assessment done by Modified Rasmussen Score.

OBSERVATION & RESULTS

TABLE 1: AGE DISTRIBUTION OF THE STUDY POPULATION

AGE(YEARS)	No. of cases	Percentage
< 30	5	13.5%
31-40	10	27.0%
41-50	15	40.5%
> 50	7	18.9%
Total	37	100.0%

The maximum patients in the present study were present in age group 41-50 years (40.5%) followed by 31-40 years (27.0%), >50 years (18.9%) and least were in <30 years with 13.5%. The mean age was 42.70±9.18 years.

FIGURE 1: AGE DISTRIBUTION OF STUDY POPULATION(YEARS)

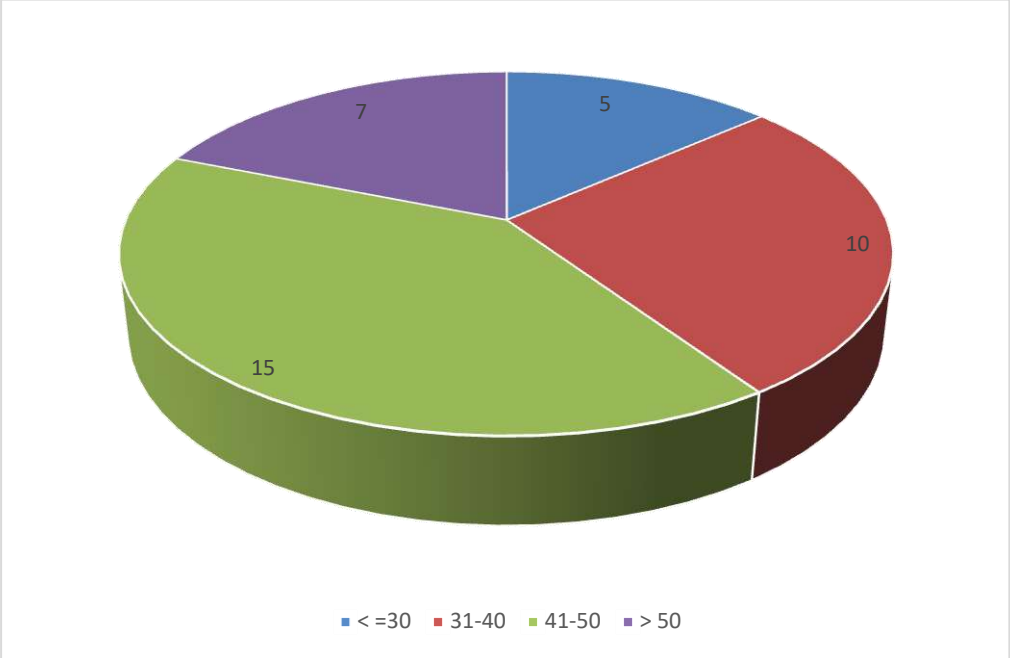


Table 2: DISTRIBUTION OF STUDY POPULATION ACCORDING TO SEX

SEX	No. of cases	Percentage
FEMALE	9	24.3%
MALE	28	75.7%
Total	37	100.0%

In our study of total 37 cases, there were 28 males (75.7%) and 9 females (24.3%), there is predominance of male population in our study.

FIGURE 2: SEX DISTRIBUTION OF STUDY POPULATION

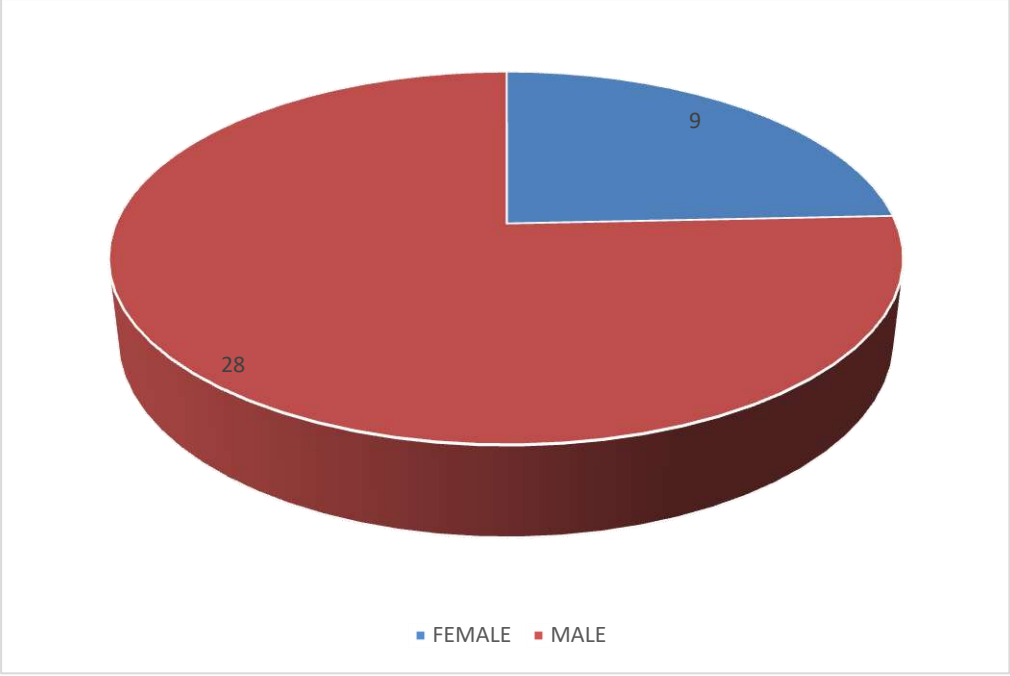


TABLE 3: DISTRIBUTION OF STUDY POPULATION ACCORDING TO OPERATIVE SIDE

OPERATIVE SIDE	No. of cases	Percentage
LEFT	17	45.9%
RIGHT	20	54.1%
Total	37	100.0%

In our study out of total 37 cases, in 17 cases (45.9%) left side was involved and in 20 cases (54.1%) the right side was involved. There is right sided predominance in our study when compared to the left side.

FIGURE 3: DISTRIBUTION OF STUDY POPULATION ACCORDING TO OPERATIVE SIDE

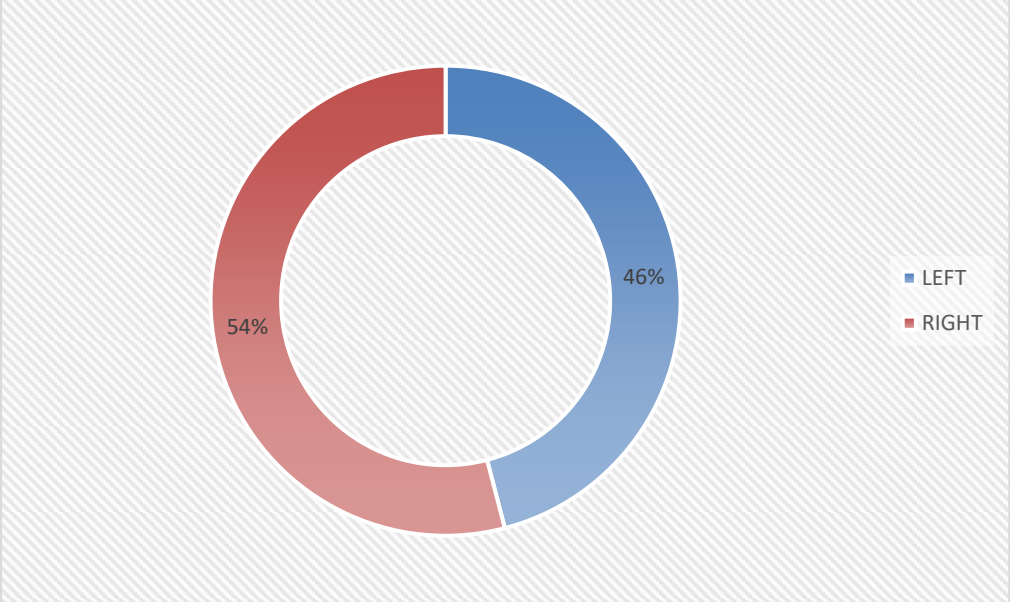


TABLE 4: DISTRIBUTION OF STUDY POPULATION ACCORDING TO MODE OF INJURY

MODE OF INJURY	No. of cases	Percentage
ROAD SIDE ACCIDENT	32	86.5%
ACCIDENTAL FALL FROM HEIGHT	5	13.5%

In the present study out of 37 cases, in 32 cases(86.5%) the mode of injury was roadside accidents while in 5 cases (13.5%) it was accidental fall from height. In our study,road side accident is the higher associated mode of injury when compared to accidental fall from height.

FIGURE 4: DISTRIBUTION OF STUDY POPULATION ACCORDING TO MODE OF INJURY

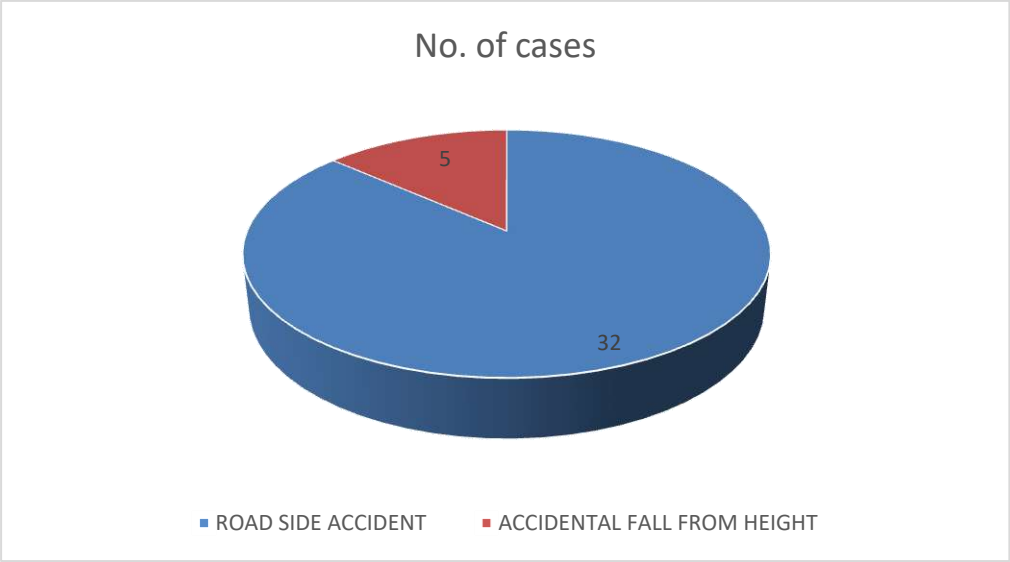


TABLE 5: DISTRIBUTION OF CASES ACCORDING TO APPROACHES USED

APPROACH		No.of cases	Percentage
MEDIAL	DIRECT MEDIAL	10	27.0
	POSTEROMEDIAL	27	73.0
LATERAL	ANTEROLATERAL	37	100%

All the cases managed were closed fractures. Out of total 37 patients enrolled in the study, in 37 patients (100%) anterolateral approach was used. In 37 patients in which medial approach was used, out of them, in 10 patients (27%) direct medial approach was used and in 27 (73%) posteromedial approach was used.

FIGURE 5: DISTRIBUTION OF CASES ACCORDING TO APPROACH USED

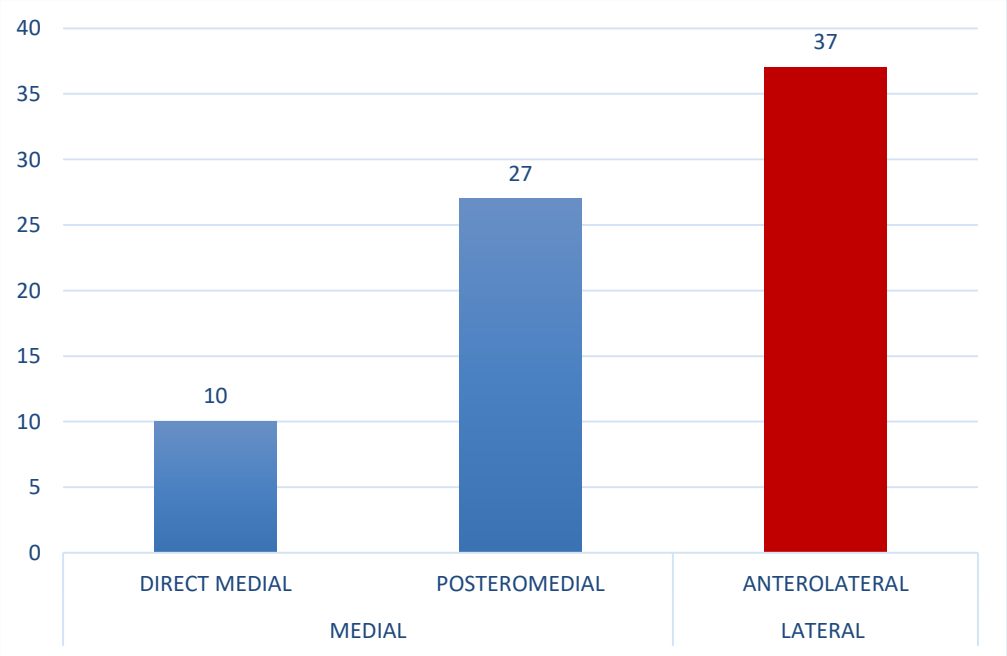


TABLE 6: DISTRIBUTION OF STUDY POPULATION ACCORDING TO SCHATZKER'S CLASSIFICATION

GRADE OF FRACTURE	No. of cases	Percentage
V	13	35.1%
VI	24	64.9%
Total	37	100.0%

In our study out of a total of 37 patients, 24 patients (64.9%) were diagnosed with grade VI Schatzker's fracture and 13 patients (35.1%) were diagnosed with grade V Schatzker's fracture.

FIGURE 6: DISTRIBUTION OF STUDY POPULATION ACCORDING TO GRADE OF FRACTURE

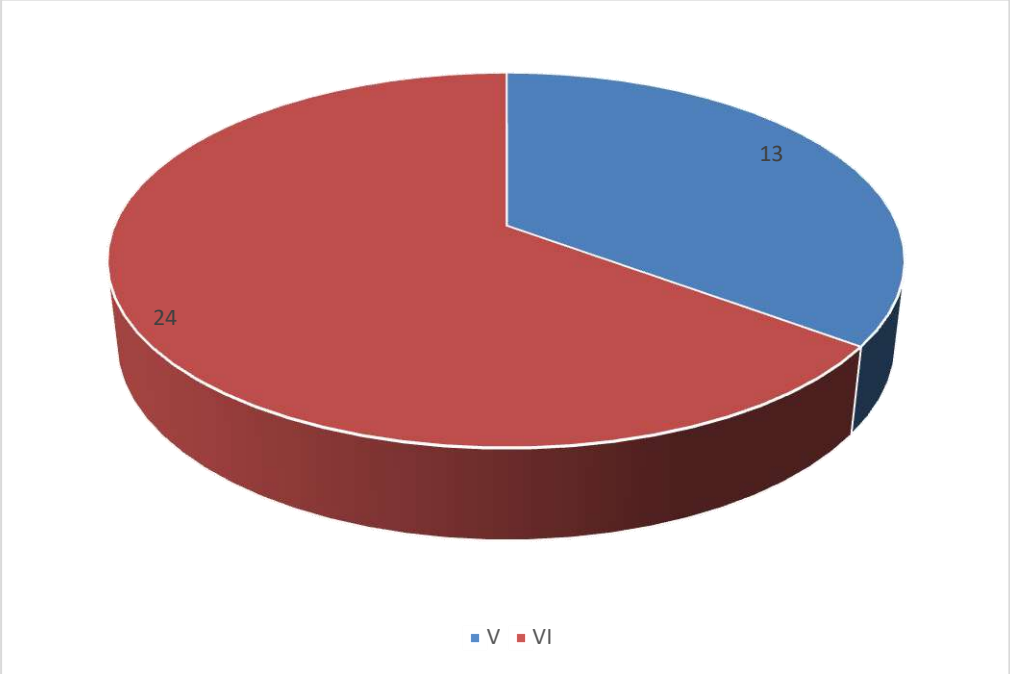


TABLE 7: DISTRIBUTION OF PATIENTS ACCORDING TO ANAESTHESIA USED

ANAESTHESIA USED	No. of cases	Percentage
Combined Spinal Anaesthesia	7	18.9%
General anaesthesia	1	2.7%
Spinal anaesthesia	29	78.4%
Total	37	100.0%

In our study out of a total 37 patients, 29 patients (78.4%) were operated under Spinal anaesthesia, 7 patients (18.9%) were operated under Combined Spinal Anaesthesia and 1 patient (2.7%) was operated under General anaesthesia.

FIGURE 7: DISTRIBUTION OF PATIENTS ACCORDING TO ANAESTHESIA USED

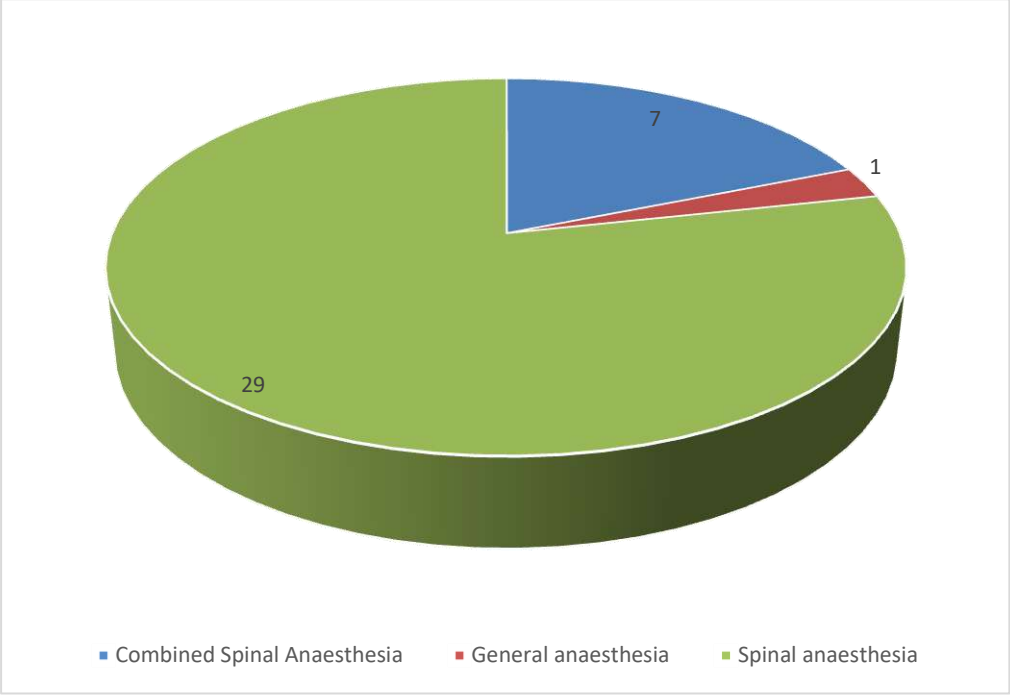


TABLE 8: DISTRIBUTION OF PATIENTS ON THE BASIS OF COMPLICATIONS

COMPLICATIONS		No. of cases	Percentage
INFECTION	SUPERFICIAL INFECTION	3	8.1%
	DEEP INFECTION	2	5.4%
HARDWARE PROBLEMS		3	8.1%
NON UNION		0	0.0%

In our study, 8 patients were having complications, out of which 3 patients were having hardware problems (implant prominence), and 5 patients were having infections. Out of 5 patients who were having infections, 3 patients were having superficial infection(stitch abscess) which was managed with stitch removal, regular antiseptic dressing for two weeks and gets resolved ,2 patients were having deep infections for which in each patient debridement was done and intravenous antibiotics given for 2 weeks and gets resolved .None of the patients were having nonunion.

FIGURE 8: DISTRIBUTION OF PATIENTS ON THE BASIS OF COMPLICATIONS

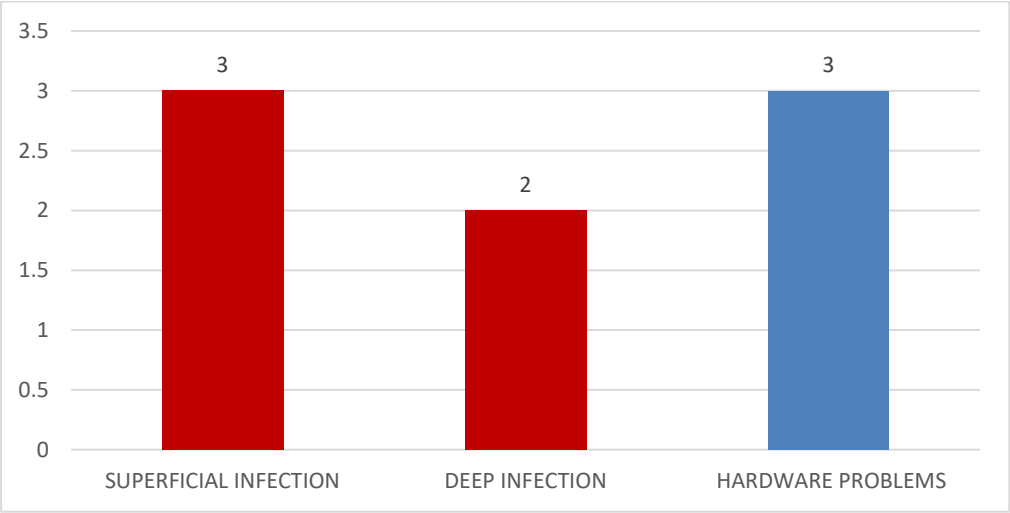


TABLE 9: DISTRIBUTION OF PATIENTS ACCORDING TO ADDITIONAL PROCEDURES REQUIRED

ADDITIONAL PROCEDURES	No. of cases	Percentage
DEBRIDEMENT	2	5.1%
BONE GRAFTING	0	0%

In our study, none of the patient required bone grafting while in 2 (5.1%) debridement was done.

FIGURE 9: DISTRIBUTION OF PATIENTS ACCORDING TO ADDITIONAL PROCEDURES

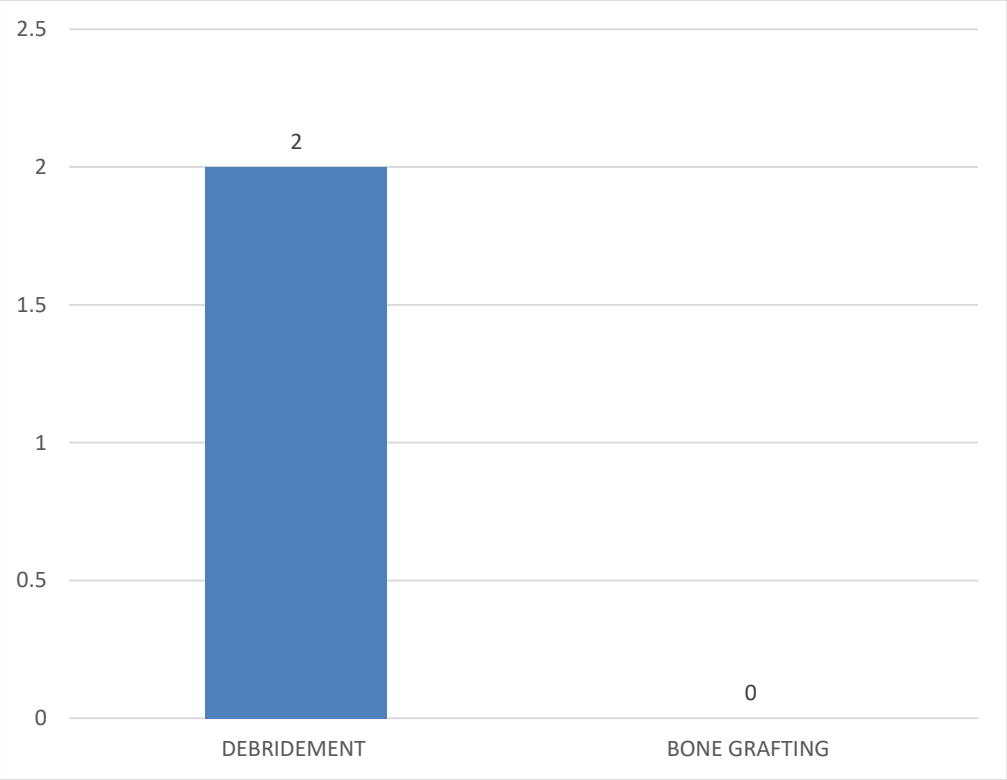


TABLE 10: COMPARING ARTICULAR DEPRESSION SCORE AT 1 MONTH AND 6 MONTHS

	1 MONTH		6 MONTH	
ARTICULAR DEPRESSION (SCORE)_1 MONTH	No. of cases	Percentage	No. of cases	Percentage
1(6-10mm)	6	16.2	1	2.7
2(<5mm)	29	78.4	25	67.6
3(none)	2	5.4	11	29.7
Total	37	100.0	37	100.0

For the first month, 6(16.2%) patients had articular depression in the range of 6-10mm while after 6 months, only 1(2.7%) patient had articular depression in the range of 6-10mm. For the first month, 29 (78.4%) patients had <5 mm of articular depression while after 6 months,25 (67.6%) patients had articular depression in the range of 6-10mm. After 1 month, only 2(5.4%) had no articular depression while after 6 months, 11(29.7%) patients had no articular depression. Constant improvement was seen with respect to articular depression at different follow ups.

TABLE 10.1: COMPARING MEAN ARTICULAR DEPRESSION SCORE AT 1 MONTH AND 6 MONTHS

ARTICULAR DEPRESSION SCORE	Mean	Std. Deviation	t	Sig. (2-tailed)
1 MONTH	1.89	.458	-387	<0.001
6 MONTH	2.27	.508		

The mean articular depression score for 1 month is 1.89±.45, for 6 months it was 2.27±.50. There was significant improvement seen at the end of 6 months overall. (p<0.001)

FIGURE 10: COMPARING ARTICULAR DEPRESSION SCORE AT 1 MONTH AND 6 MONTHS

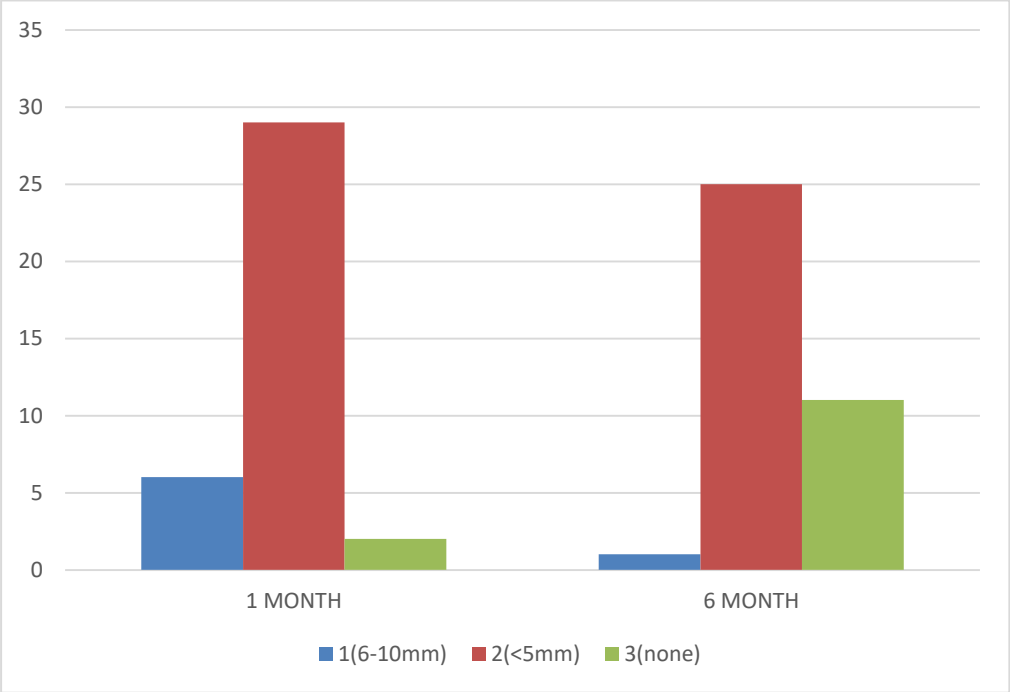


TABLE 11: COMPARING CONDYLAR WIDENING SCORE AT 1 MONTH AND 6 MONTHS

	1 MONTH		6 MONTH	
CONDYLAR WIDENING (SCORE)_1 MONTH	No. of cases	Percentage	No. of cases	Percentage
1(6-10mm)	22	59.5	9	24.3
2(<5mm)	15	40.5	28	75.7
Total	37	100.0%	37	100.0%

For the first month, 22(59.5%) patients had condylar widening in the range of 6-10mm while after 6 months, only 9(24.3%) patients had condylar widening in the range of 6-10mm. For the first month, 15(40.5%)) patients had <5mm of condylar widening while after 6 months, 28 (75.7%) patients had condylar widening in the range of <5mm. Constant improvement was seen with respect to condylar widening at different follow ups.

TABLE 11.1: COMPARING MEAN CONDYLAR WIDENING SCORE AT 1 MONTH AND 6 MONTHS

ARTICULAR DEPRESSION SCORE	Mean	Std. Deviation	t	Sig. (2-tailed)
1 MONTH	1.89	.458	-4.41	<0.001
6 MONTH	2.27	.508		

The mean condylar widening score for 1 month is 1.89±.45, for 6 months it was 12.27±.50 There was significant improvement seen at the end of 6 months($p<0.001$)

FIGURE 11: COMPARING CONDYLAR WIDENING SCORE AT 1 MONTH AND 6 MONTHS

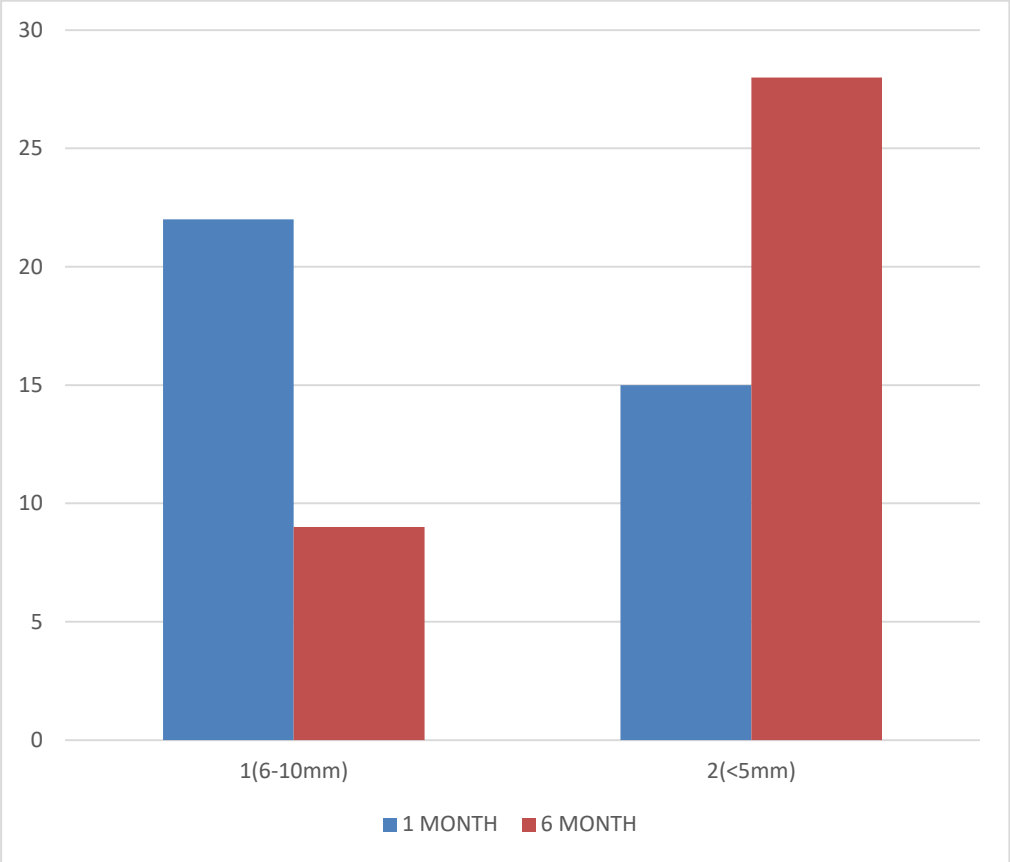


TABLE 12: COMPARING VARUS-VALGUS ANGULATION SCORE AT 1 MONTH AND 6 MONTHS

	1 MONTH		6 MONTH	
ANGULATION (SCORE)	No. of cases	Percentage	No. of cases	Percentage
1(10-20 degree)	22	59.5	1	2.7
2(<10 degree)	15	40.5	18	48.6
3(none)	0	0	18	48.6
Total	37	100.0	37	100.0

Of 37 patients, for the first month, 22 patients (59.5%) were having angulation between 10-20 degree, 15 patients (40.5%) were having angulation <10 degree. At the end of 6 months, the score improved with only 1(2.7%) patients having angulation between 10-20 degree, 18(48.6%) having score< 10 degree while 18(48.6%) having no angulation.

TABLE 12.1 : COMPARING MEAN VARUS-VALGUS ANGULATION SCORE AT 1 MONTH AND 6 MONTHS

	ANGULATION SCORE	Mean	Std. Deviation	t	Sig. (2-tailed)
Pair 1	1 MONTH	1.41	.498	-6.81	<0.001
	6 MONTH	2.46	.558		

The mean ANGULATION SCORE for 1 month is 1.41±.498, for 6 months it was 2.46±.55. There was significant improvement seen at the end of 6 months overall from the first month. (p<0.001).

FIGURE 12: COMPARING VARUS-VALGUS ANGULATION SCORE AT 1 MONTH AND 6 MONTHS

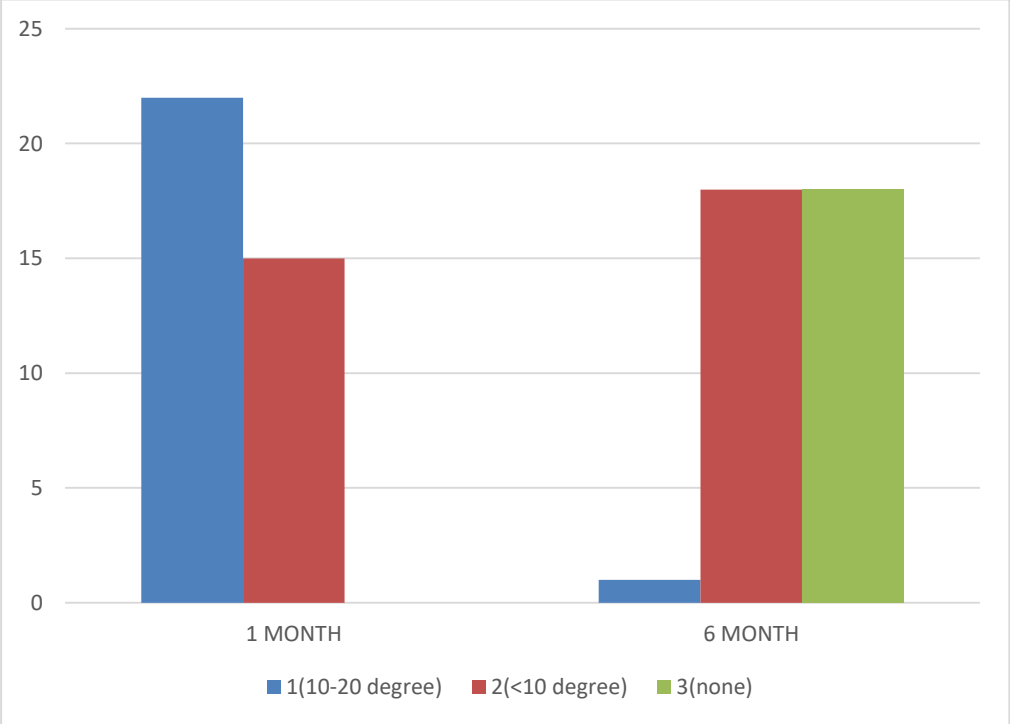


TABLE 13: COMPARING OSTEOARTHROSIS SCORE AT 1 MONTH AND 6 MONTHS

OSTEOARTHROSIS (SCORE)	1 MONTH		6 MONTHS	
	No. of cases	Percentage	No. of cases	Percentage
PROGRESSION BY >1 GRADE(-1)	0	0	0	0
PROGRESSION BY 1 GRADE (0)	0	0	2	5.4
NONE/NO PROGRESS(1)	37	100	35	94.6
Total	37	100.0%	37	100.0

Out of total 37 patients, at the period of 1 month,all patients were having osteoarthrosis score 1 i.e. there was no progression to Osteoarthrosis while at 6 months,in 2 patients(5.4%) the Osteoarthrosis progressed by grade 1(score 0)

TABLE 13.1: COMPARING MEAN OSTEOARTHROSIS SCORE AT 1 MONTH AND 6 MONTHS

	OSTEOARTHRITIS SCORE	Mean	Std. Deviation	t	Sig. (2-tailed)
Pair 1	6 MONTH	.95	.229	-1.4	.193
	1 MONTH	1.00	.000		

The mean osteoarthritis for 6 month is 0.95±.22, for 6 months it was 1±00. No significant difference was seen at six month with respect to osteoarthritis. (p=.193)

FIGURE 13: COMPARING OSTEOARTHROSIS SCORE AT 1 MONTH AND 6 MONTHS

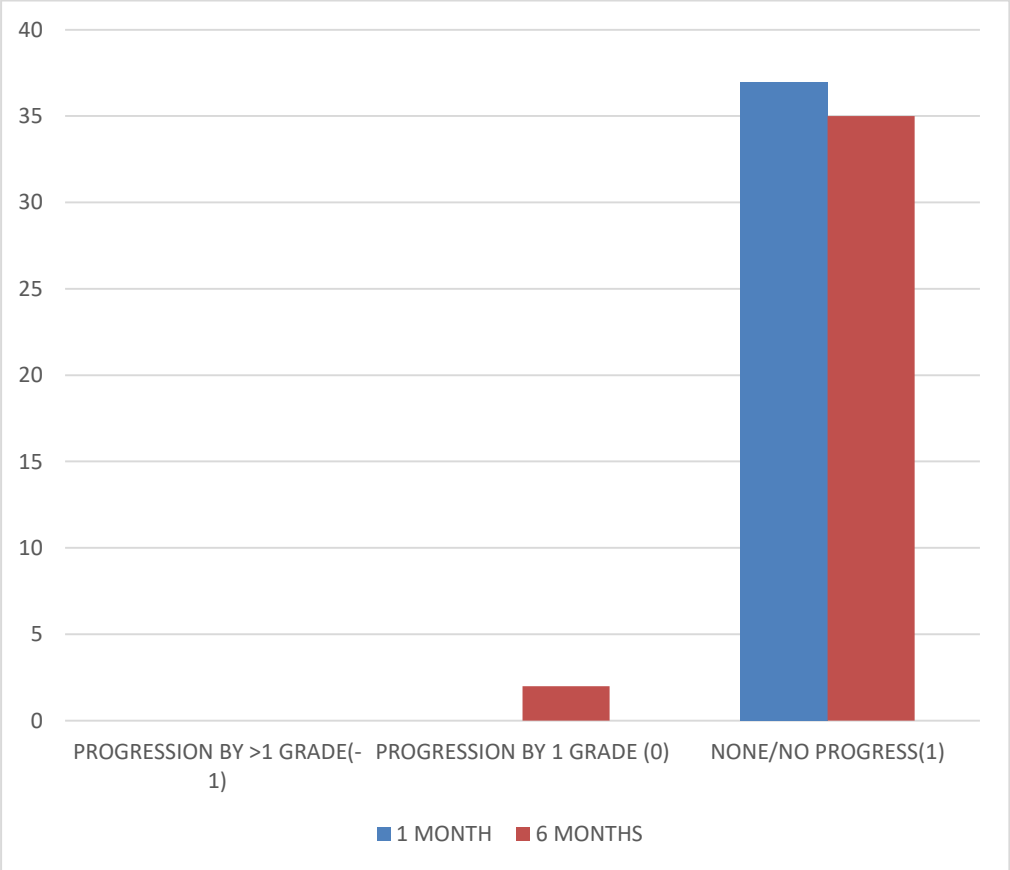


TABLE 14: COMPARING PAIN SCORE AT 1 MONTH AND 6 MONTHS

	1 MONTH		6 MONTH	
PAIN (SCORE)	No. of cases	Percentage	No. of cases	Percentage
1(CONSTANT PAIN AFTER ACTIVITY)	1	2.7	0	0.0%
3(STABBING PAIN IN CERTAIN POSITION)	10	27.0	2	5.4
5(occasional)	26	70.3	20	54.1
6(none)	0	0	15	40.5
Total	37	100.0%	37	100.0%

Out of total 37 patients, 26 patients (70.3%) had occasional pain , 10 patients (27.0%) had stabbing pain at a certain position, 1 patient (2.7%) had constant pain after activity and none of the patients was diagnosed with pain score 6(no pain) at a period of 1 month. And after a period of 6 months, 15 patients (40.5%) were showing pain score 6(no pain) , 20 patients (54.1%) were showing pain score 5(occasional) and 2 patient (5.4%) was showing pain score 3(stabbing pain in certain position).

TABLE 14.1: COMPARING MEAN PAIN SCORE AT 1 MONTH AND 6 MONTHS

	PAIN SCORE	Mean	Std. Deviation	t-test	p-value
Pair 1	1 MONTH	4.35	1.060	-4.7	0.000
	6 MONTH	5.30	.740		

The mean pain score for 1 month was 4.35±1.06, for 6 months it was 5.30±.74. The pain score significantly improved over a period of six months. ($p<0.001$).

FIGURE 14: COMPARING PAIN SCORE AT 1 MONTH AND 6 MONTHS

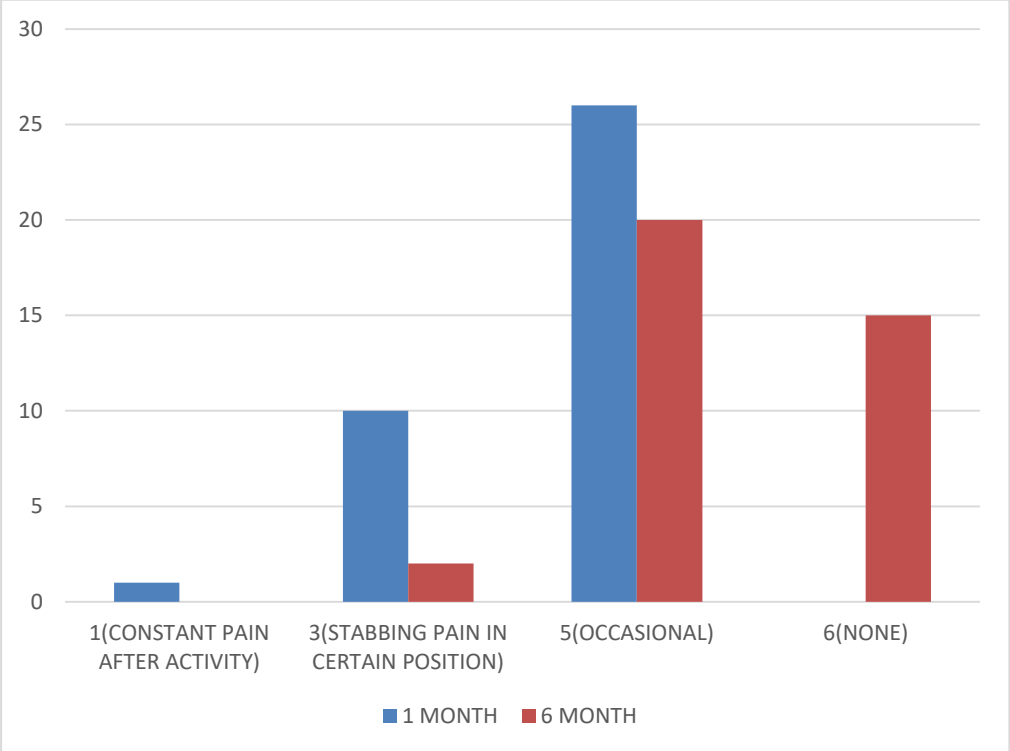


TABLE 15: COMPARING WALKING CAPACITY SCORE AT 1 MONTH AND 6 MONTHS

	1 MONTH		6 MONTH	
WALKING CAPACITY (SCORE)	No. of cases	Percentage	No. of cases	Percentage
WALKING INDOOR ONLY(0)	0	0	0	0
WALKING<15 MINS(1)	8	21.6	0	0
WALKING OUTDOOR 15 MINS TO 1HR(3)	24	64.9	5	13.5
WALKING OUTDOOR FOR MORE THAN 1HR(5)	4	10.8	22	59.5
NORMAL WALKING CAPACITY FOR AGE(6)	1	2.7	10	27.0
Total	37	100.0	37	100.0

At 1 month, 8 patients were at score one(walking<15 mins)while at 6 months, none were at score one(walking<15 mins). At 1 month 24(64.9%) have walking capacity of 15 min to 1 hour(3) while at 6 months, 5(13.5%) have walking capacity 15 min to 1 hour(3). 4 patients had walking capacity for more than 1 hour(5) at 1 month while as compared to 22 (59.5%) at six months . only one patient(2.7%) had normal walking capacity(6) at 1 month as compared to 27% at six months.

TABLE 15.1: COMPARING MEAN WALKING CAPACITY SCORE AT 1 MONTH AND 6 MONTHS

	WALKING CAPACITY SCORE	Mean	Std. Deviation	t-test	p-value
Pair 1	1 MONTH	2.86	1.251	-9.1	0.000
	6 MONTH	5.00	.913		

The mean WALKING CAPACITY SCORE for 1 month 2.86 ±1.25, while at 6 months it was 5 ±.91. The walking capacity score significantly improved over a period of six months. (p<0.001).

FIGURE 15: COMPARING WALKING CAPACITY SCORE AT 1 MONTH AND 6 MONTHS

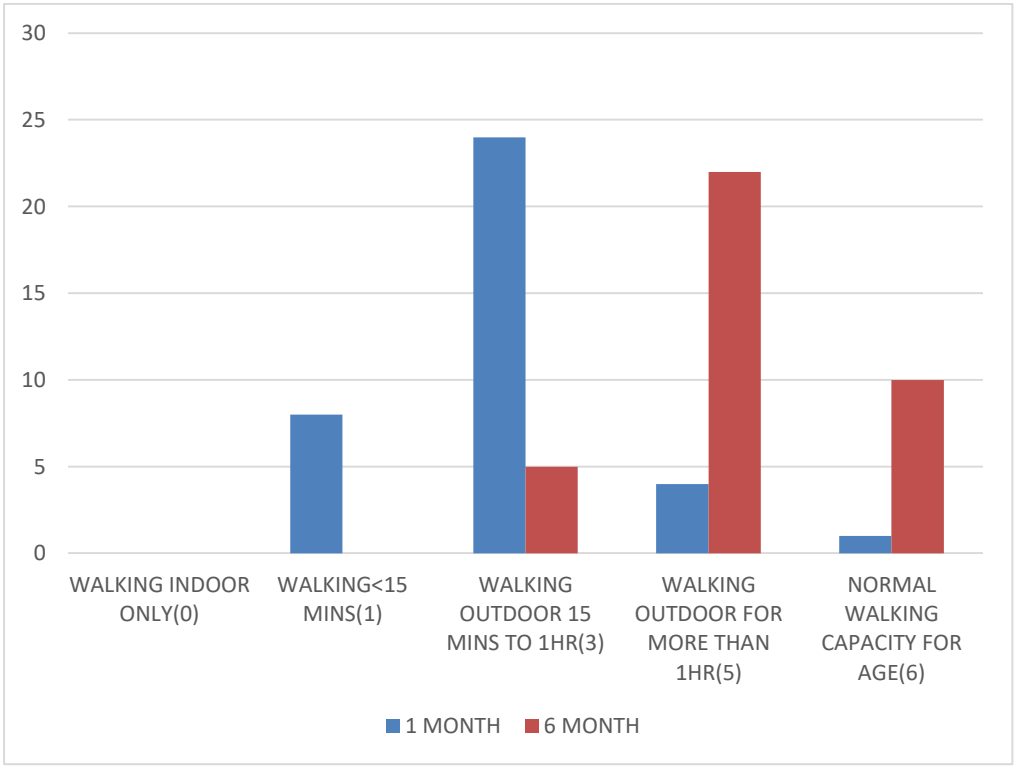


TABLE 16: COMPARING KNEE EXTENSION SCORE AT 1 MONTH AND 6 MONTHS

	1 MONTH		6 MONTH	
KNEE EXTENSION (SCORE)	No. of cases	Percentage	No. of cases	Percentage
LACK OF EXTENSION >10 DEGREE(0)	4	10.8	0	0
LACK OF EXTENSION <10 DEGREE(2)	28	75.7	16	43.2
NORMAL(4)	5	13.5	21	56.8
			1	2.7

After a period of 6 months, 21 patients (56.8%) were showing score 4 and 16 patients (43.2%) were showing score 2 as compared to 10.8%and 75.7% with lack of extension >10 degree and <10degree at 1 month. The knee extension was normal in 13.5% at one month as compared to 56.8% at six months.

TABLE 16.1: COMPARING MEAN KNEE EXTENSION SCORE AT 1 MONTH AND 6 MONTHS

	Knee extension score	Mean	Std. Deviation	t-test	p-value
Pair 1	1 MONTH	2.05	.998	-4.7	0.000
	6 MONTH	3.19	1.11		

The mean knee extension score for 1 month was 12.05 ±.998, for 6 months it was 3.19± 1.1. The knee extension score significantly improved over a period of six months. (p<0.001).

FIGURE 16: COMPARING KNEE EXTENSION SCORE AT 1 MONTH AND 6 MONTHS

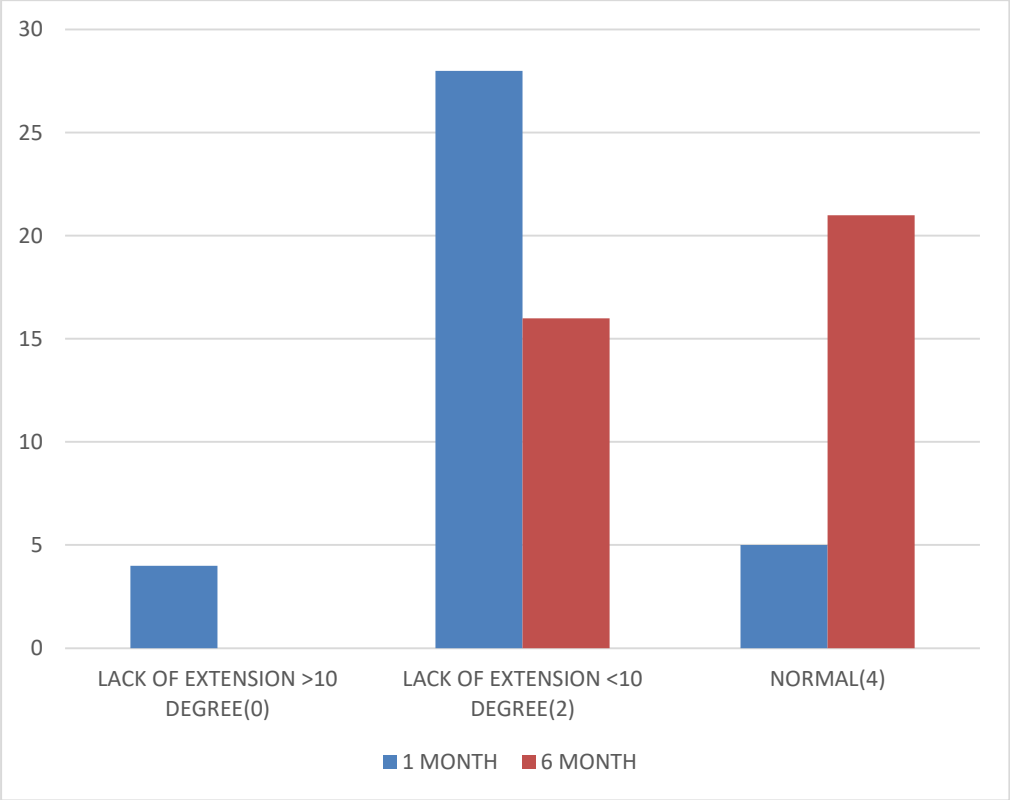


TABLE 17: COMPARING TOTAL RANGE OF MOTION SCORE AT 1 MONTH AND 6 MONTHS

	1 MONTH		6 MONTH	
TOTAL RANGE OF MOTION (SCORE)	No. of cases	Percentage	No. of cases	Percentage
AT LEAST 60^0(1)	4	10.8	0	0
AT LEAST 90^0 (3)	17	45.9	4	10.8
AT LEAST 120^0 (5)	14	37.8	15	40.5
FULL(6)	2	5.4	18	48.6
Total	37	100.0	37	100.0

After a period of 6 months, 18 patients (48.6%) were showing score 6, 15 patients (40.5%) were showing score 5 and 4 patients (10.8%) were showing score 3 as compared to 2 (5.4%) who have full range of motion while 14(37.8%) have 120degree 17(45.9%) have atleast 90 degree and 4(10.8%) have 60 degree range of motion at 1 month

FIGURE 17.1: COMPARING TOTAL RANGE OF MOTION SCORE AT 1 MONTH AND 6 MONTHS

	RANGE OF MOTION SCORE	Mean	Std. Deviation	t-test	p-value
Pair 1	1 MONTH	3.70	1.412	-7.2	0.000
	6 MONTH	5.27	.932		

The mean range of motion score for 1 month was 3.70 ±1.41, for 6 months it was 5.72±.932. The knee extension score significantly improved over a period of six months. ($p<0.001$).

FIGURE 17: COMPARING TOTAL RANGE OF MOTION SCORE AT 1 MONTH AND 6 MONTHS

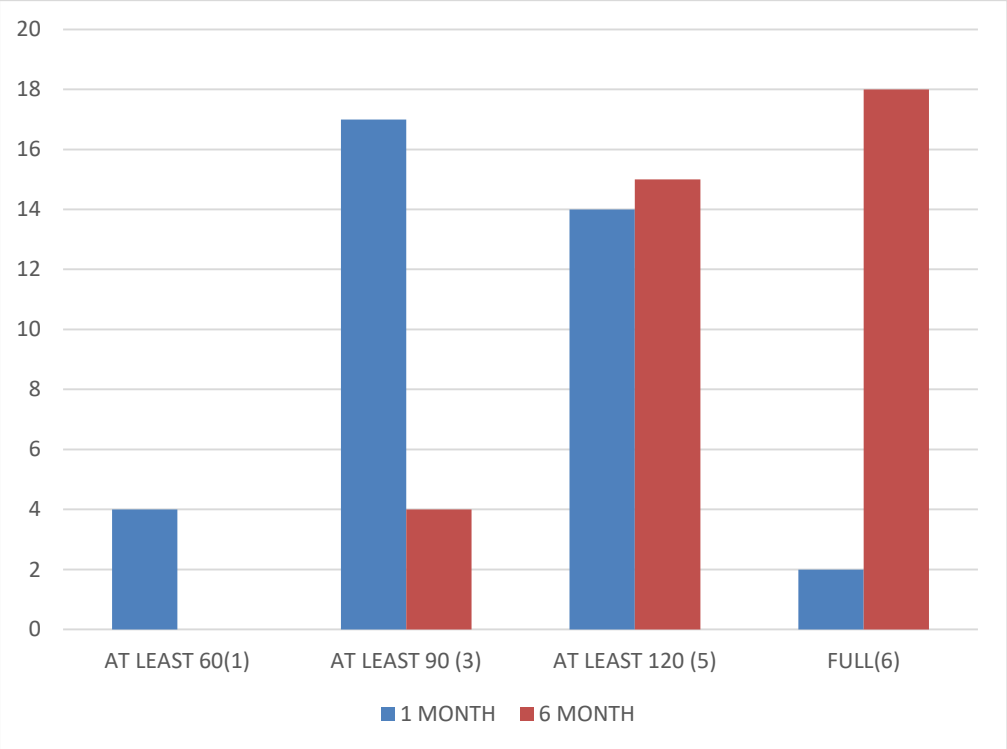


TABLE 18: COMPARING STABILITY SCORE AT 1 MONTH and 6 MONTHS

	1 MONTH		6 MONTH	
STABILITY (SCORE)_1 MONTH	No. of cases	Percentage	No. of cases	Percentage
INABILITY IN EXTENSION <10 DEGREE(2)	2	5.4	1	2.7
ABNORMAL STABILITY IN 20 DEGREE FLEXION(4)	6	16.2	1	2.7
NORMAL STABILITY IN EXTENSION AND 20 DEGREE FLEXION(6)	29	78.4	35	94.6
Total	37	100.0	37	100.0

On comparing stability scores in 37 patients, at a period of 1 month, 29 patients (78.4%) were showing score 6, 6 patients (16.2%) were showing score 4 and 2(5.4%) of the patients were showing score 2. After a period of 6 months, 35 patients (94.6%) were showing score 6 and 1 patient (2.7%) was showing score 4 and 2 each.

TABLE 18.1: COMPARING MEAN STABILITY SCORE AT 1 MONTH AND 6 MONTHS

MEAN STABILITY SCORE	Mean	Std. Deviation	t-test	p-value
1 MONTH	5.46	1.120	-1.87	0.083
6 MONTH	5.84	.727		

The mean stability score for 1 month was 5.46 ±1.12, for 6 months it was 5.84±.72. The knee extension score did not significantly improve over a period of six months.

FIGURE 18: COMPARING STABILITY SCORE AT 1 MONTH AND 6 MONTHS

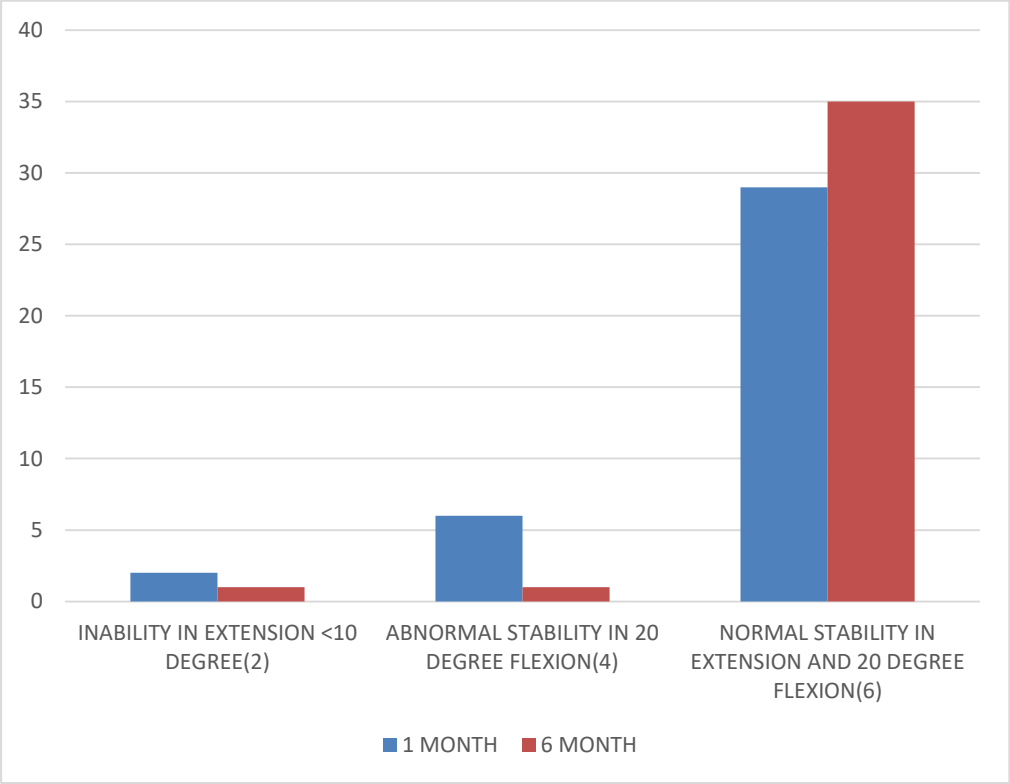


TABLE 19: COMPARING POWER OF QUADRICEPS SCORE AT 1 MONTH AND 6 MONTHS

	1 MONTH		6 MONTH	
POWER OF QUADRICEPS (SCORE)	No. of cases	Percentage	No. of cases	Percentage
GRADE <3(- 2)	0	0	0	0
GRADE 3-4(1)	34	91.9	7	18.9
GRADE 5(2)	3	8.1	30	81.1
Total	37	100.0	37	100.0

On comparing the power of quadriceps scores in a total of 37 patients, at period 1 month,34 patients (91.9%) were showing score 1, 3 patients (8.1%) were showing score 2 and after a period of 6 months, 7 patients (18.9%) were showing score 2 and 30 patients (81.8%) were showing score 1.

TABLE 19.1: COMPARING MEAN POWER OF QUADRICEPS SCORE AT 1 MONTH AND 6 MONTHS

	POWER OF QUADRICEPS	Mean	Std. Deviation	t-test	p-value
Pair 1	1 MONTH	1.08	.277	-4.986	0.000
	6 MONTH	1.81	.397		

The mean range of motion scores for 1 month .1.08±.277, for 6 months it was 1.81±.397. The knee extension score significantly improved over a period of six months. (p<0.001).

FIGURE 19: COMPARING POWER OF QUADRICEPS SCORE AT 1 MONTH AND 6 MONTHS

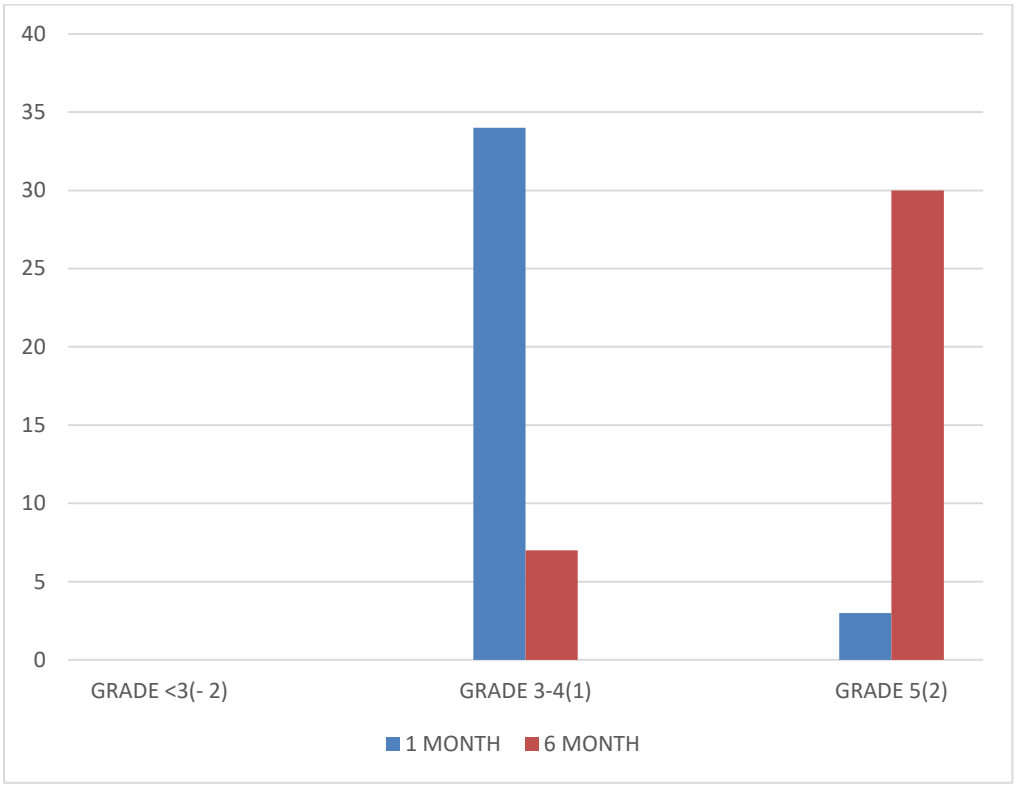


TABLE 20: COMPARING RADIOLOGICAL MODIFIED RASMUSSEN CRITERIA AT 1 MONTH AND 6 MONTHS

	1 MONTH		6 MONTH	
Total score	No. of cases	Percentage	No. of cases	Percentage
Poor	3	8.1	0	0%
Fair	29	78.4	5	13.5
Good	5	13.5	27	73.0
Excellent	0	0	5	13.5
Total	37	100.0%	37	100.0

We observed significant improvement at the end of six months compared to 1 month. At 1 month, 8.1 % were poor compared to 0 at six months. 29 (78.4%) had fair and 5(13.5%) had fair scores in 1 month while at 6 months . 27(73%) had good scores and 13.5% had good scores at end of 6 months and 1 month respectively. 13.5% had excellent scores at end of 6 months while none had excellent at 1 month.

TABLE 20.1: MEAN COMPARISON OF RADIOLOGICAL MODIFIED RASMUSSEN CRITERIA AT 1 MONTH AND 6 MONTHS

	Total radiological score	Mean	Std. Deviation	t-test	p-value
Pair 1	1 MONTH	5.65	.857	-9.9	0.000
	6 MONTH	7.49	.870		

Of a total of 37 patients, the mean value of radiological modified Rasmussen criteria at 1 month was 5.65 ±.85 std. deviation while after six months it significantly improved to 7.49±.870.

FIGURE 20: COMPARING RADIOLOGICAL MODIFIED RASMUSSEN CRITERIA AT 1 MONTH AND 6 MONTHS

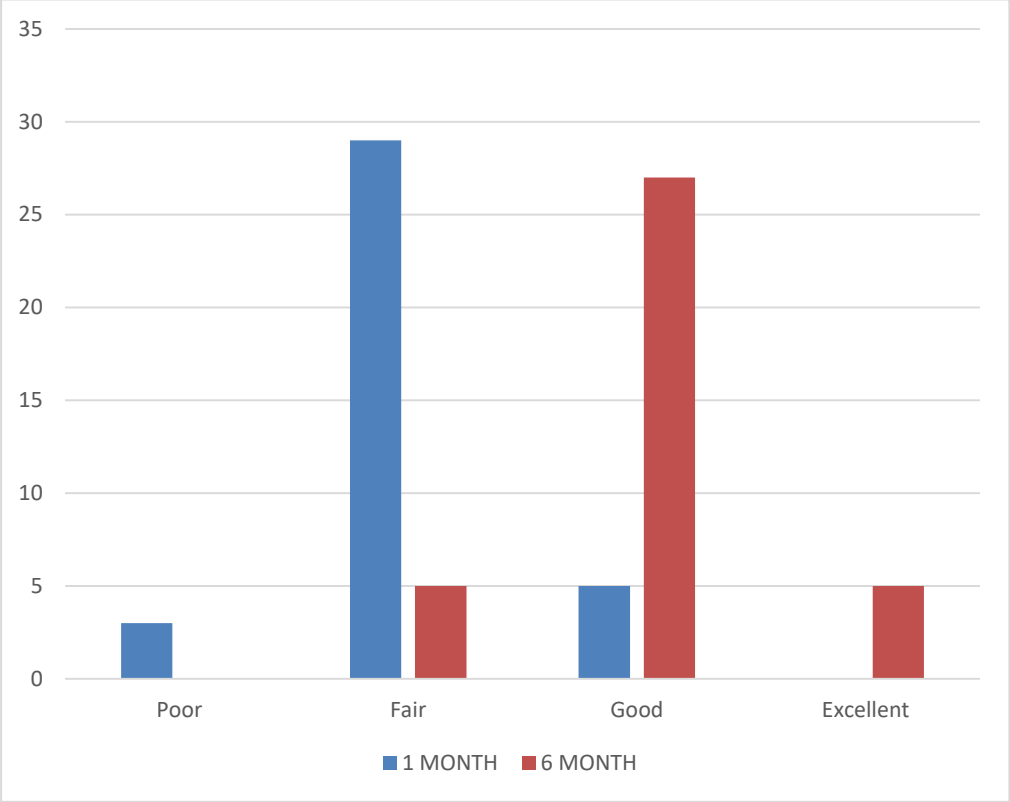


TABLE 21: COMPARING CLINICAL MODIFIED RASMUSSEN CRITERIA AT 1 MONTH AND 6 MONTHS

	1 MONTH		6 MONTH	
CLINICAL - MODIFIED RASMUSSEN CRITERIA	No. of cases	Percentage	No. of cases	Percentage
poor	13	35.1	1	2.7
fair	23	62.2	3	8.1
good	1	2.7	20	54.1
excellent	0	0	13	35.1
Total	37	100.0	1	100

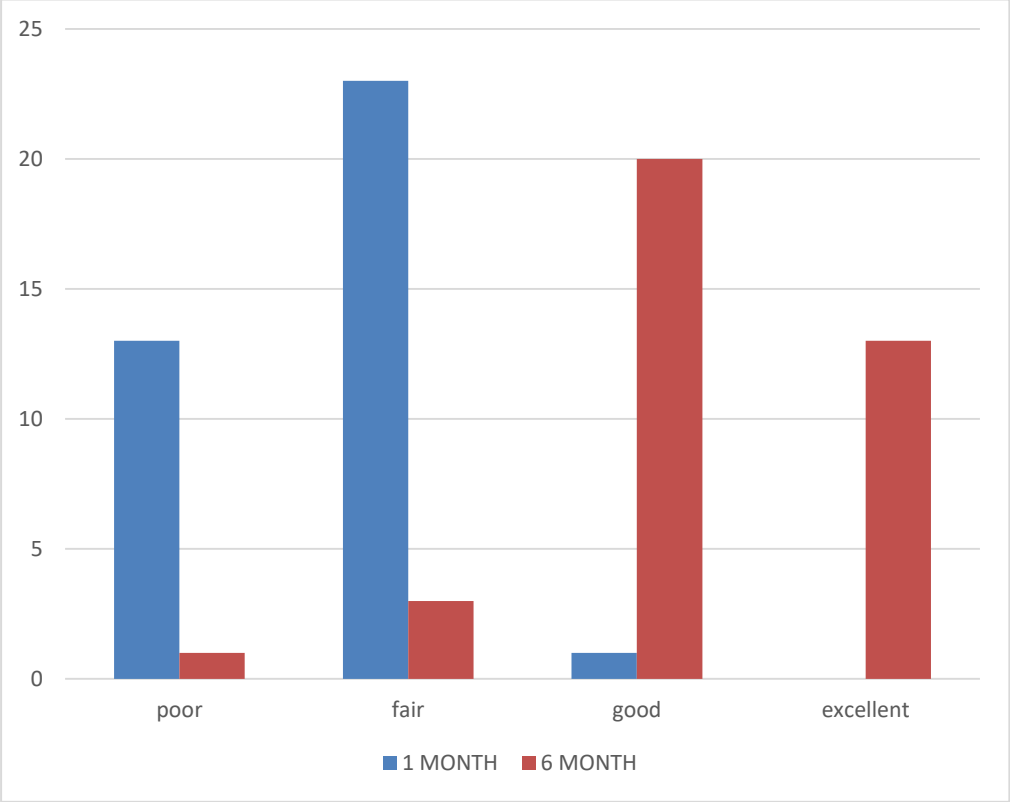
On comparing clinical modified Rasmussen criteria in total 37 patients, at a period of 1 month,13 patients (35.1%) were showing poor score, 23patients (62.2%) were showing fair score, 1 patients (2.7%) were showing good score and none of patient was showing excellent score. After a period of 6 months, 13 patients (35.1%) were showing excellent scores, 20 patients (54.1%) were showing good scores, 3 patients (8.1%) were showing fair scores and 1 patient (2.7%) was showing a poor score.

TABLE 21.1: MEAN COMPARISON OF CLINICAL MODIFIED RASMUSSEN CRITERIA AT 1 MONTH AND 6 MONTHS

	Total clinical score	Mean	Std. Deviation	t-test	p-value
Pair 1	1 MONTH	19.51	3.220	-10.1	0.000
	6 MONTH	26.35	2.679		

Of a total of 37 patients, the mean value of clinical modified Rasmussen criteria at 1 month was 19.51 ±3.22 std. deviation while after six months it significantly improved to 26.35±2.67.

FIGURE 21: MEAN MINIMUM AND MAXIMUM CLINICAL MODIFIED RASMUSSEN CRITERIA AT 1 MONTH AND 6 MONTHS



DISCUSSION

Proximal tibia fractures account for around 1% of fractures in adults. Proximal tibial fractures are intricate fractures created by high-or low-velocity injury, the ideal treatment of high energy tibial plateau fracture remains contentious. Open reduction and internal fixation with a rigid implant achieves the goal of anatomic, articular congruency, and mechanical alignment restoration while allowing early remobilization, but open reduction internal fixation compromises the soft tissue structures and has been associated with major wound complications [74].

Tibial plateau fractures are more commonly seen in the active, younger age group due to their exposure to high velocity motor vehicle accidents. Closed treatment of these injuries has had very little success in reducing depressed or displaced fracture fragments; this initiated the need for open reduction and internal fixation in most displaced and unstable fractures. It is also extremely important to do a stable fragment fixation and ligament repair to regain the complete range of movements [74].

Open reduction and internal fixation has the advantage of direct visualization of fracture, complete reduction, and fixation, but there is higher risk of soft tissue complications, joint stiffness and deep compartment infection. The hybrid fixator system avoids these soft tissue complications, but risks are malunion, pin site infections and reduced patient compliance in maintaining the hybrid fixator [5].

The invention of locking compression plates has allowed the surgeons in using MIPPO technique for unilateral plating with improved care and management in handling the soft tissue. Laterally applied locking compression plates provide better stability in context of complex proximal 1/3rd tibia fracture associated with metaphyseal comminution and serves as an good alternative to medial plate or external fixator which are used for additional support of the medial column when a non-locking plate is used for bicondylar fractures. This plate allows

fixation through single incision to avoid wound dehiscence, prolonged immobilization and infection associated with extensile approaches [75].

There is no reliable universal scoring system to assess the radiological and functional outcome of these fractures. Past researchers used multiple scoring systems like Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC),Rasmussen, oxford knee score(OKS),Honkonen Jarvinen score(HJK) and knee society score(KSS). In our study, we have assessed the functional outcome of the patients using Modified Clinical Rasmussen score which is a subjective score based on patient's experience and we have assessed the radiological outcome of the patients using Modified Radiological Rasmussen score which is an objective score based on surgeon's observation.

STUDY POPULATION

In our study, the maximum patients in the present study were present in age group 41-50 years (40.5%) followed by 31-40 years (27.0%), >50 years (18.9%) and least were in <=30 years with 13.5%. the mean age was 42.70±9.18 years. In a study by Prabhakar et al conducted on 21 patients with tibial plateau class V and VI fractures the maximum patients were in age groups 40-50 years (52.4%) followed by 31-40 years (33.3%) [76]. Haranadh et al [77] showed that among 12 cases, the incidence of fracture in age group 20 -30 and 41-50 was 66.68%. This was in accordance with our present study.

Male dominated in our study. In our study of total 37 cases, there were 28 males (75.7%) and 9 females (24.3%). This was in accordance with the series by Kumar et al who showed 16 males and 5 females out of total 21 patients. Haranadh et al [77] showed the incidence of male was more compared to females in the ratio of 5:1. This is explained by more active life style of males and higher chance of road traffic accidents in them.

In our study out of total 37 cases in 17 cases (45.9%) left side was involved and in 20 cases (54.1%) right side was involved. In a study by Haranadh et al [77] the incidence of fracture on right side was 33.33 % and on left side was 66.67% which was higher. Prabhakar et al in

their study showed the incidence of fracture in right side was 42.9% and in left side was 57.1% which nearly equal. In a study by Raj et al [73] 11 /20 had left side injury while 9/20 have right side injury. In our present study right side was more involved then left side.

In our study out of total 37 cases, in 32(86.5%) the mode of injury was road side accidents while in 5(13.5%) it was accidental fall from height. In a study by Prabhakar et al76 and Haranadh et al [77] all the cases were of road side accidents. Raj et al73 in their study showed that in 26/30 patients the mode of injury was road side accidents while in 4 the cause was fall.

In our study out of total 37 patients, 24 patients (64.9%) were diagnosed with grade VI Schatzker's fracture and 13 patients (35.1%) were diagnosed with grade V fracture. In a study by Raj et al [73] 5 patients had grade V while 25 have grade VI fracture. In a study by Prabhakar et al [76] of 21 fractures, 7 patients (33.3%) had grade V fracture and 14 patients (66.7%) had grade VI fracture.In a study by Haranadh et al [77] of 12 patients, 6 patients (50%) had grade V fracture and 6 patients (50%) had grade VI fracture.

PROCEDURE

In our study out of total 37 patients, 29 patients (78.4%) were operated under Spinal anesthesia, 7 patients (18.9%) were operated under Combined Spinal Anesthesia and 1 patient (2.7%) was operated in General anesthesia .All the cases managed were of closed fracture. Out of total 37 patients enrolled in the study, in 27 patients (73%) the posteromedial approach was used, in 10 patients (27.0%) medial approach was used and in 37(100%) anterolateral approach was used. Grafting was performed in none of the patients while in 2 patients who developed deep infection bone debridement was done.

In a study by Prabhakar et al [76] all patients underwent standard surgical procedure by anterolateral & posteromedial approach. Lateral locking plates were used for lateral plateau and Buttress, Semi tubular, Recon plates were used for medial plateau. In their study bone Grafting was used for 9 patients (42.9%) to fill metaphyseal defect. In a study by Raj et al [63] Primary bone grafting was done in four patients.

In our study, 3 patients (8.1%) were diagnosed with hardware problems, 5 patients had infection of which 3 (8.1%) had superficial infection while 2 (5.4%) had deep infection and none of the patient had non-union. The incidence of deep wound infection in cases with dual plate fixation was reported to be between 4.7-8.4% by different authors. Patil et al reported superficial wound infection in 1 patient (2.7%) with dual plating [78]. Neogi et al had a deep infection rate of 3.12%. Superficial infection was found in 2 patients (6.66%) in a study by raj et al that healed with prolonging antimicrobial therapy [79].

Infection is the most common complication associated with dual plating which could be avoided by gentle handling and waiting for 5-6 days after an injury so that tissue edema could subside and skin condition could improve.

Radiological outcome

In our present study radiological outcome were assessed by modified Rasmussen criteria. The parameters scored were articular depression score, condylar widening, varus-valgus angulation and osteoarthrosis.

The mean articular depression score for 1 month is 1.89±.45, for 6 months it was 2.27±.50. There was significant improvement seen at the end of 6 months overall. ($p<0.001$). The mean condylar widening score for 1 month is 1.89±.45, for 6 months it was 12.27±.50 There was significant improvement seen at the end of 6 months($p<0.001$). The mean varus-valgus angulation score for 1 month is 1.41±.498, for 6 months it was 2.46±.55. There was significant improvement seen at the end of 6 months overall from the first month. ($p<0.001$). The mean osteoarthritis for 6 month is 0.95±.22, for 6 months it was 1±00. No significant difference was seen at six month with respect to osteoarthritis. ($p=.193$).

Of a total of 37 patients, the mean value of radiological modified Rasmussen criteria at 1 month was 5.65 ±.85 std. deviation while after six months it significantly improved to 7.49±.870.

We observed significant improvement at the end of six months compared to 1 month. At 1 month, 3(8.1 %) were having poor score compared to 0 at six months. 29(78.4%) had fair and 5(13.5%) had

good scores in 1 month. 27(73%) had good scores and 5(13.5%) had good scores at end of 6 and 1 month respectively. 13.5% had excellent scores at end of 6 months while none had excellent at 1 month.

Ya et al conducted a similar study with 28 patients and had 55% in excellent score, 41% in good score and 4% in fair score [80]. In another study conducted by Lobenhoffer et al [81] they had 21 patients, and the results were 57% of patients had excellent results, 42% with good results. Study of Berber R et al [82] revealed 54% excellent results, 36% good and 9% fair results.

In a study by Maniknanda et al [83] study of 20 patients, 55% of patients had excellent results, 40% good and 5% fair results at end of three months.

Soring et al in their study showed, the Rasmussen's radiological outcome was excellent in 8 (25%), good in 20 (62.5%), fair in 3 (9.4%) and poor in 1 (3.1%) of case with average score of 7.9 (range, 4 – 10) [84]. In a study by Khatri et al, the Final Radiological outcome was 'excellent' in 19 (63.33%) patients, 'good' in 11 (36.67%) patients, 'fair' in 0 (0%) patients and 'poor' in 0 (0%) patients [85].

All the above mentioned studies were in accordance to our present study.

Anatomic reduction of the proximal tibial articular surfaces and appropriate alignment of the limb axis with stable internal fixation allows early joint motion, which is the final goal of the treatment. In cases of bicondylar tibial plateau fractures, only lateral plating leads to varus deformity which can be prevented by bipillar plating through dual incisions. Anterolateral and posteromedial skin incisions allow a wide skin bridge between the two incisions and decrease the chances of skin necrosis and infections and without compromising the vascularity of underlying bone. Anterolateral approach allows elevation of the depressed lateral plateau and bone graft if required to be placed under the elevated fragment and fixation with proximal tibial locking plate. This fixed angle construct provides angular stability and prevents collapse of the elevated fragment. The posteromedial or posterior approach provides buttressing of the medial plateau and application of

posterior or posteromedial plates. This combined approach allows the reduction and fixation of entire tibial plateau. Thus in cases of this typical fracture pattern we recommend fixation of the medial plateau with posterior or posteromedial plates.

Functional outcome

On comparing clinical modified Rasmussen criteria in total 37 patients, at a period of 1 month, 13 patients (35.1%) were showing poor score, 23 patients (62.2%) were showing fair score, 1 patient (2.7%) were showing good score and none of patient was showing excellent score. After a period of 6 months, 13 patients (35.1%) were showing excellent scores, 20 patients (54.1%) were showing good scores, 3 patients (8.1%) were showing fair scores and 1 patient (2.7%) was showing a poor score.

Of a total of 37 patients, the mean value of clinical modified Rasmussen criteria at 1 month was 19.51 ±3.22 std. deviation while after six months it significantly improved to 26.35±2.67.

In a study by Khatri et al [85] the average modified Rasmussen's functional score was 26.7 points (range, 19 – 30). The overall satisfactory result, in their series was 84.4%. These results are comparable with our present study. Zhai Q et al operated 26 patient and the final Rasmussen's score was excellent in 17 cases and good in 9 cases with the average Rasmussen's score of 27.2 (range, 21- 30) [86].

The functional outcome study done by Neil Rohra [27] et al showed 24 patients (70.59%) had Excellent, 8 patients (23.53%) had good and 1 patient (2.94%) were each of poor and fair.14 This finding suggests that good biomechanical fixation by dual plating allows early range of motion and rehabilitation and provide optimal functional recovery and outcome in bicondylar Tibial plateau fracture.

Rijal et al in their study found that there were 60% Excellent, 36% Good, 4% fair Results. This finding suggests that good biomechanical fixation by bilateral plating allows early range of motion and rehabilitation and provide optimal functional recovery and outcome in bicondylar Tibial plateau fracture [87].

Yu et al., [88] Prasad et al., [66] Zhang et al.,[20] Oh et al., [89] Barei et al [90]., and Barei et al [63]., all did different studies and concluded that double plate fixation technique in high-energy Schatzker V and VI tibial plateau fractures via a 2-incision technique is a feasible treatment option for bicondylar and complex tibial plateau fractures and is matching our findings in our present study.

SUMMARY AND CONCLUSION

The present study was conducted in orthopedic department of Dayanand Medical College and Hospital to assess the clinical and radiological outcome of surgically treated proximal tibia fracture with dual plating. Patients after giving consent participated in the study.The cases were followed up using the proforma for 6 months. Using the patient records as well as personal and telephonic interview.

The radiological outcome was based on the Modified Rasmussen Score for radiological assessment and clinical outcome was based on Modified Rasmussen Score for clinical assessment, the results of the present study are summarized below:

- Proximal tibia fractures are more common in males as compared to females. 75.7% of the patients were males in our study.
- There was right sided predominance in our study when compared to the left side. In our study, in 17 cases (45.9%) left side was involved and in 20 cases (54.1%) the right side was involved.
- Most common mode of proximal tibia fracture was road side accidents. In our study of 37 cases, in 32 cases (86.5%), the mode of injury was roadside accidents while in 5 cases (13.5%) it was accidental fall from height.
- For classification, Schatzker's classification was used. In our study, 24 patients (64.9%) were diagnosed with grade VI Schatzker's fracture and 13 patients (35.1%) were diagnosed with grade V Schatzker's fracture.
- In our study, 8 patients were having complications, out of which 3 patients were having hardware problems(implant prominence),and 5 patients were having infections. Out of 5 patients who were having infections, 3 patients were having superficial infection (stitch abscess) which was managed with stitch removal, regular antiseptic dressing for two weeks and gets resolved, 2 patients were having deep infections for which

in each patient debridement was done and intravenous antibiotics given for 2 weeks and gets resolved .None of the patients were having nonunion.

- In our study none of the patient required bone grafting while in 2 (5.1%) debridement was done only once postoperatively for treating the deep infection complication and then intravenous antibiotic course was given for two weeks and the deep infection was resolved.
- Significant improvement was observed in Modified Rasmussen Radiological score at the end of six months compared to 1 month. At the end of six months, out of total 37 patients, 5(13.5%) patients had excellent score, 27(73%) patients had good score, 5 (13.5%) patients had fair score while none of the patient was having poor score.
- Significant improvement was observed in Modified Rasmussen Clinical score at the end of six months compared to 1 month. At the end of six months, out of total 37 patients, 13(35.1%) patients had excellent score, 20(54.1%) patients had good score, 3(8.1%) patients had fair score and 1(2.7%) patient was having poor score.

Conclusion

- Osteosynthesis in bicondylar tibial plateau fractures in adults is a challenge to every orthopaedic surgeon.
- Though there are number of implants and surgical techniques to address the problem, the surgical treatment of tibial plateau fracture remain controversial.
- Better preoperative planning in selection of approach can minimise the soft tissue injury and unnecessary periosteal stripping.
- Better preoperative planning in selection of approach/implant should be strictly based on good clinical judgement of fracture pattern, bone quality and intraoperative fracture reduction.
- Dual plating is ideal for all bicondylar tibial plateau fracture of schatzker's grade V and VI with appropriate timing of surgery,

understanding the anatomy, LCP system, appropriate technique with dual incision, the complications can be minimised , giving excellent to good results.

- Based on our research and our result being encouraging in comparison to the literature, we recommend to fix the tibial plateau fracture with dual incision and dual plate as it provide good surgical exposure, minimal soft tissue complications rate, reasonable amount of stability, acceptable alignment of articular congruity, reasonable time to union and allow early range of motion of knee & early weight bearing with good functional results.
- A congruent and anatomical reduction is an essential key for better outcome in treated proximal tibia fracture, as it helps in nourishment of articular cartilage, facilitates early mobilization and decrease chances of delayed degeneration.

LIMITATIONS

- Our study population was very small comprising only 37 patients. So, it is difficult to come for any statistical correlation and to ascertain the outcome of bicondylar tibial plateau fracture fixed with dual incision and dual plate as well as to determine the ideal method of fixation techniques
- Our average follow up period was 6 months. A long term follow up of five to ten years could have been more significant to study the post traumatic arthritis.

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CASE ILLUSTRATION

CASE 1:

PRE OP

IMMEDIATE POST OP

1 MONTH POST OP

6 MONTH POST OP

6 MONTH FUNCTIONAL OUTCOME- KNEE ROM

CASE 2:

PRE OP

IMMEDIATE POST OP

1 MONTH POST OP

6 MONTH POST OP

6 MONTH FUNCTIONAL OUTCOME- KNEE ROM

CASE 3:

PREOP

IMMEDIATE POST OP

1 MONTH POST OP

6 MONTH POST OP

6 MONTH FUNCTIONAL OUTCOME-KNEE ROM

CASE 4:

PREOP

IMMEDIATE POST OP

3MONTHS POST OP

6 MONTHS POST OP

6 MONTH FUNCTIONAL OUTCOME-KNEE ROM

CASE 5:

PRE OP

IMMEDIATE POST OP

1 MONTH POST OP

6 MONTH POST OP

6 MONTH FUNCTIONAL OUTCOME-KNEE ROM

Sociodemographic							Causes type and mode of injury									Post op complication and procedure		
S NO.	MRD	INITIALS	OPERATIVE SIDE	SEX	AGE	DOI	RSA	AFH	DOS	MEDIAL	LATERAL	OPEN/ CLOSED FRACTURE	GRADE OF FRACTURE	DISPLACED/ UNDISPLACED FRACTURE	ANAESTHESIA USED	INFECTION	NON UNION	HARDWARE PROBLEMS
1	1237162	SS	2	M	45 YRS	10/01/2022	Y	N	29/01/2022	PM	AL	CF	VI	D	SA	N	N	N
2	1243764	KS	1	M	29 YRS	24/01/2022	Y	N	25/01/2022	PM	AL	CF	VI	D	SA	N	N	N
3	1249295	VA	2	M	32 YRS	05/02/2022	Y	N	17/02/2022	PM	AL	CF	VI	D	SA	N	N	N
4	1007804	RS	2	M	47 YRS	02/01/2021	N	Y	05/01/2021	PM	AL	CF	VI	D	SA	N	N	N
5	1059135	SY	1	F	33 YRS	15/03/2021	Y	N	25/03/2021	DM	AL	CF	VI	D	SA	N	N	N
6	245802	PS	1	M	47 YRS	13/04/2021	Y	N	15/04/2021	PM	AL	CF	V	D	SA	N	N	N
7	1089011	MB	1	F	28 YRS	24/03/2021	N	Y	20/04/2021	DM	AL	CF	V	D	SA	N	N	N
8	1149190	RG	2	F	50 YRS	08/08/2021	Y	N	17/08/2021	DM	AL	CF	VI	D	SA	N	N	N
9	1215981	PB	2	F	55 YRS	29/11/2021	Y	N	30/12/2021	DM	AL	CF	VI	D	SA	N	N	N
10	1016422	HS	2	M	30 YRS	22/01/2021	Y	N	23/01/2021	PM	AL	CF	VI	D	SA	N	N	N
11	875191	BS	2	M	50 YRS	01/01/2020	Y	N	08/01/2020	PM	AL	CF	VI	D	SA	N	N	N
12	880728	PS	2	F	20 YRS	13/01/2020	Y	N	17/01/2020	DM	AL	CF	VI	D	SA	N	N	N
13	883422	AK	1	M	37 YRS	19/01/2020	Y	N	20/01/2020	PM	AL	CF	V	D	SA	N	N	N
14	873230	RK	2	M	52 YRS	27/12/2019	Y	N	25/01/2020	PM	AL	CF	VI	D	SA	N	N	N
15	902927	RK	2	M	51 YRS	20/02/2020	Y	N	26/02/2020	PM	AL	CF	VI	D	SA	SUPERFICIAL INFECTION	N	N
16	904140	A	2	M	43 YRS	22/02/2020	Y	N	04/03/2020	PM	AL	CF	VI	D	CSA	N	N	N
17	915369	VG	1	M	46 YRS	12/03/2020	Y	N	17/03/2020	PM	AL	CF	V	D	SA	SUPERFICIAL INFECTION	N	N
18	922698	VS	2	F	24 YRS	17/04/2020	Y	N	17/04/2020	DM	AL	CF	V	D	CSA	N	N	N
19	941125	YM	1	M	49 YRS	17/06/2020	Y	N	06/10/2020	PM	AL	CF	V	D	CSA	DEEP INFECTION	N	N
20	997651	N	1	F	40 YRS	09/12/2020	Y	N	15/12/2020	DM	AL	CF	V	D	SA	N	N	N
21	999555	SS	1	M	53 YRS	15/12/2020	Y	N	29/12/2020	PM	AL	CF	VI	D	CSA	SUPERFICIAL INFECTION	N	N
22	740626	NK	2	M	50 YRS	31/05/2019	Y	N	16/06/2019	PM	AL	CF	VI	D	SA	N	N	N
23	806525	HK	2	F	49 YRS	12/09/2019	Y	N	14/09/2019	DM	AL	CF	V	D	GA	N	N	N
24	274103	SK	1	M	54 YRS	08/10/2019	Y	N	08/10/2019	PM	AL	CF	VI	D	SA	N	N	N
25	825436	JS	2	M	37 YRS	07/10/2019	Y	N	10/10/2019	PM	AL	CF	V	D	SA	N	N	N
26	857561	SL	2	M	53 YRS	26/11/2019	Y	N	28/11/2019	PM	AL	CF	V	D	SA	N	N	N
27	783064	VD	2	M	40 YRS	06/08/2019	Y	N	13/08/2019	PM	AL	CF	VI	D	SA	N	N	N
28	774344	RR	1	F	50 YRS	24/07/2019	Y	N	25/07/2019	DM	AL	CF	VI	D	SA	DEEP INFECTION	N	N
29	833197	RS	2	M	54 YRS	18/10/2019	Y	N	20/10/2019	PM	AL	CF	VI	D	SA	N	N	N
30	1165298	GS	1	M	42 YRS	01/09/2021	Y	N	02/09/2021	PM	AL	CF	V	D	SA	N	N	Y
31	771949	HSB	1	M	36 YRS	24/07/2019	Y	N	25/07/2019	PM	AL	CF	VI	D	SA	N	N	N
32	927477	DD	2	M	49 YRS	04/06/2020	N	Y	05/06/2020	PM	AL	CF	VI	D	SA	N	N	N
33	1132846	SSB	1	M	35 YRS	06/07/2021	N	Y	06/08/2021	PM	AL	CF	VI	D	SA	N	N	Y
34	1148476	PK	2	M	40 YRS	04/08/2021	Y	N	05/08/2021	DM	AL	CF	V	D	SA	N	N	N
35	935016	KS	1	M	45 YRS	29/05/2020	N	Y	16/06/2020	PM	AL	CF	V	D	CSA	N	N	N
36	1246028	RB	1	M	47 YRS	29/01/2022	Y	N	10/02/2022	PM	AL	CF	VI	D	CSA	N	N	N
37	1043876	JS	1	M	38 YRS	25/02/2021	Y	N	08/03/2021	PM	AL	CF	VI	D	CSA	N	N	Y

				Modified Rasmussen Score radiological outcome (at 1 and 6 months)																
S NO.	MRD	BONE GRAFTING	DEBRIDEMENT	ARTICULAR DEPRESSION (SCORE)1 MONTH	1 MONTH CW	1 MONTH VVA	1 MONTH OOST	1 month tota	CAT 1 MONTH	ARTICULAR DEPRESSION (SCORE) 6 MONTHS	6 MONTHS CW	6 MONTHS VVA	6 MONTHS OOST	6 month tota	CAT 6 MONTH	1 MONTH PAIN	1 MONTH WC	1 MONTH KE	1 MONTH TRM	1 MONTH STAB
1	1237162	N	N	1	2	2	1	6	2	2	2	2	1	7	3	5	3	2	3	6
2	1243764	N	N	2	1	1	1	5	2	3	2	3	1	9	4	3	3	2	3	6
3	1249295	N	N	2	1	2	1	6	2	3	2	2	1	8	3	3	3	2	1	4
4	1007804	N	N	2	2	2	1	7	3	2	2	2	1	7	3	5	3	2	5	6
5	1059135	N	N	2	2	1	1	6	2	2	2	3	1	8	3	5	1	2	3	6
6	245802	N	N	2	2	1	1	6	2	2	2	3	1	8	3	5	1	2	5	6
7	1089011	N	N	2	2	1	1	6	2	2	2	3	1	8	3	5	1	2	6	6
8	1149190	N	N	2	1	1	1	5	2	2	1	3	1	7	3	5	5	4	5	2
9	1215981	N	N	1	1	2	1	5	2	3	2	3	1	9	4	5	1	0	3	4
10	1016422	N	N	2	1	2	1	6	2	2	2	2	1	7	3	5	1	2	3	6
11	875191	N	N	2	2	2	1	7	3	2	2	2	0	6	2	5	3	2	5	6
12	880728	N	N	2	1	1	1	5	2	2	1	3	1	7	3	5	6	4	6	4
13	883422	N	N	2	1	1	1	5	2	2	2	3	1	8	3	5	3	2	5	6
14	873230	N	N	1	1	1	1	4	1	2	2	2	1	7	3	5	3	4	5	4
15	902927	N	N	1	1	2	1	5	2	3	1	2	1	7	3	5	3	2	3	6
16	904140	N	N	2	1	2	1	6	2	2	1	2	1	6	2	5	3	2	3	6
17	915369	N	N	2	1	1	1	5	2	3	1	1	1	6	2	5	5	2	3	6
18	922698	N	N	2	1	1	1	5	2	3	1	3	1	8	3	5	3	2	5	6
19	941125	N	Y	1	1	1	1	4	1	2	1	2	0	5	2	1	1	0	1	6
20	997651	N	N	2	1	1	1	5	2	2	2	2	1	7	3	3	3	2	3	6
21	999555	N	N	2	1	1	1	5	2	2	2	2	1	7	3	5	3	2	1	6
22	740626	N	N	1	1	1	1	4	1	1	2	3	1	7	3	5	3	2	5	6
23	806525	N	N	2	2	1	1	6	2	2	2	3	1	8	3	5	3	2	3	6
24	274103	N	N	2	2	1	1	6	2	2	2	3	1	8	3	5	3	2	5	6
25	825436	N	N	3	2	1	1	7	3	3	2	3	1	9	4	5	3	4	3	6
26	857561	N	N	2	2	1	1	6	2	2	2	3	1	8	3	3	1	2	3	6
27	783064	N	N	2	1	2	1	6	2	2	1	2	1	6	2	5	5	2	5	2
28	774344	N	Y	2	2	2	1	7	3	2	2	2	1	7	3	5	1	2	3	6
29	833197	N	N	2	1	2	1	6	2	3	2	2	1	8	3	3	3	4	3	6
30	1165298	N	N	3	2	1	1	7	3	3	2	3	1	9	4	5	3	2	5	6
31	771949	N	N	2	1	2	1	6	2	3	1	2	1	7	3	3	3	2	1	6
32	927477	N	N	2	2	1	1	6	2	3	2	3	1	9	4	3	3	0	3	4
33	1132846	N	N	2	1	2	1	6	2	2	2	2	1	7	3	3	3	2	5	6
34	1148476	N	N	2	2	1	1	6	2	2	2	3	1	8	3	5	3	2	3	6
35	935016	N	N	2	1	2	1	6	2	2	2	2	1	7	3	3	5	2	5	4
36	1246028	N	N	2	2	1	1	6	2	2	2	3	1	8	3	5	3	2	5	6
37	1043876	N	N	2	1	2	1	6	2	2	2	2	1	7	3	3	3	0	3	6

Modified Rasmussen Score clinica outcome (at 1 and 6 months)												
S NO.	MRD	1 MONTH POQ	1 MONTH clinical tota	1 MONTH clinical CAT	6 MONTHS PAIN	6 MONTHS WC	6 MONTHS KE	6 MONTHS TRM	6 MONTHS STAB	6 MONTHS POQ	6 MONTH clinical tota	6 MONTH CLINICAL CAT
1	1237162	1	20	2	5	5	2	5	6	2	25	3
2	1243764	1	18	1	6	5	4	6	6	2	29	4
3	1249295	1	14	1	6	5	4	5	6	2	28	4
4	1007804	1	22	2	5	3	4	6	6	2	26	3
5	1059135	1	18	1	5	5	2	6	6	2	26	3
6	245802	1	20	2	5	5	4	6	6	2	28	4
7	1089011	2	22	2	5	5	2	5	6	2	25	3
8	1149190	1	22	2	6	5	2	5	6	2	26	3
9	1215981	1	14	1	6	6	4	6	6	2	30	4
10	1016422	1	18	1	6	6	4	5	6	2	29	4
11	875191	1	22	2	5	6	4	5	6	2	28	4
12	880728	2	27	3	5	5	2	6	6	2	26	3
13	883422	1	22	2	5	5	4	5	6	2	27	3
14	873230	1	22	2	5	5	4	6	6	2	28	4
15	902927	1	20	2	5	3	2	3	6	1	20	2
16	904140	1	20	2	5	5	4	5	6	1	26	3
17	915369	1	22	2	3	5	2	5	6	2	23	2
18	922698	1	22	2	5	6	2	6	6	2	27	3
19	941125	1	10	1	3	3	2	3	6	1	18	1
20	997651	1	18	1	5	5	4	5	6	1	26	3
21	999555	1	18	1	6	5	4	3	6	1	25	3
22	740626	1	22	2	5	6	2	6	6	2	27	3
23	806525	1	20	2	6	5	2	6	6	2	27	3
24	274103	1	22	2	5	5	4	5	6	2	27	3
25	825436	1	22	2	6	6	4	6	6	2	30	4
26	857561	1	16	1	5	5	2	6	6	2	26	3
27	783064	1	20	2	5	5	2	6	4	2	24	3
28	774344	1	18	1	5	3	2	3	6	1	20	2
29	833197	1	20	2	6	6	2	5	6	2	27	3
30	1165298	1	22	2	6	6	4	6	6	2	30	4
31	771949	1	16	1	5	6	4	5	6	2	28	4
32	927477	1	14	1	6	5	4	6	6	2	29	4
33	1132846	1	20	2	5	3	4	6	6	2	26	3
34	1148476	2	21	2	6	5	4	6	2	2	25	3
35	935016	1	20	2	6	6	2	5	6	2	27	3
36	1246028	1	22	2	6	5	4	5	6	2	28	4
37	1043876	1	16	1	6	5	4	6	6	1	28	4

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The Principal,
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Subject: Approval of Plan of Thesis.

This is to inform you that the Faculty of Medical Sciences in its meeting held on 29.10.2021 has approved the plan of thesis of **Avi Badhan**, a student of your college for **MS Orthopaedics** along with the names of Supervisor/Co-Supervisor as under:-

Topic Plan of Thesis

A study on clinical and radiological outcome of proximal tibia fracture with dual plating.

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The student has to submit the four copies of thesis (along with PDF format) , to the Controller of Examinations, BFUHS, Faridkot, at least six months before the commencement of theory examination, if he/she is otherwise eligible to take the examination. He /She must directed to attach a photocopy of this letter with the forwarding letter while submitting thesis to the University along with the letter of approval of University for change of supervisor/Co-Supervisor, change of topic,(if any).

S P Singh

Dr. S P Singh MS(Oph)
Controller of Examinations

Note :

139. If any discrepancy found regarding topic of thesis or Supervisor/Co-Supervisor, inform undersigned within one month after issue of this letter.

140. The student may submit the thesis as per the schedule already conveyed i.e for May/June examination 30th Nov of the preceding the year of examination and for Nov/Dec examinations 31st May of the year of examination.

A STUDY ON CLINICAL AND RADIOLOGICAL OUTCOME OF PROXIMAL TIBIA FRACTURE WITH DUAL PLATING

THESIS PROPOSAL

FOR APPROVAL OF SUBJECT OF THESIS TO BE SUBMITTED

IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

MASTER OF SURGERY

IN

ORTHOPAEDICS

OF THE

BABA FARID UNIVERSITY OF HEALTH SCIENCES

FARIDKOT

MARCH 2021 **DR. AVI BADHAN**

DEPARTMENT OF ORTHOPAEDICS
DAYANAND MEDICAL COLLEGE AND HOSPITAL
LUDHIANA

ABSTRACT OF PLAN OF THESIS

Title	A STUDY ON CLINICAL AND RADIOLOGICAL OUTCOME OF PROXIMAL TIBIA FRACTURE WITH DUAL PLATING
For the degree of	M.S. Orthopaedics
Name of the candidate	Dr. Avi Badhan
Supervisor	Dr. Rajnish Garg, Professor & Head, Department of Orthopaedics, DMC&H Ludhiana
Co-supervisor	Dr. Deepak Jain, Professor, Department of Orthopaedics, DMC&H Ludhiana
Institution	Dayanand Medical College & Hospital, Ludhiana
University	Baba Farid University of Health Sciences, Faridkot

Introduction: Tibial plateau fractures are intra-articular fractures of major weight bearing joint. These fractures can be simple injuries with predictable excellent outcome after non-operative treatment to complex fracture patterns. Common modes of injury in young adults are motor vehicle accidents, bumper strike injuries and in elderly, sports injuries and fall. Dual tibia plating is placing the locking or buttress plate laterally on the lateral side of proximal tibia and medially on the medial side of proximal tibia via two incision approach i.e lateral plate through an anterolateral approach and medial plate through an posteromedial approach.

Aim of Study:The aim of the study is to assess the clinical and radiological outcome of surgically treated proximal tibia fracture with dual plating.

Materials & methods: It will be a retrospective study for cases from 1st June 2019 to 1st June 2020 and prospective study from 1st June 2020 to 31st March 2022 for all the admissions in Dayanand Medical College and Hospital under Department of Orthopaedics diagnosed as Schatzker type V and VI proximal tibia fracture, managed by dual tibia plating. Modified Rasmussen Score for clinical assessment will be used to assess the clinical outcome and Modified Rasmussen Score for radiological assessment will be used to assess the radiological outcome.

Clinical Significance: Dual tibia plating has become a popular method in management of Schatzker type V and VI as in this method, there is early mobilisation of knee joint, better distribution of forces along the axis of the bone, better load sharing capability as compared to single lateral plate, prevention of medial condyle collapse, prevention of varus deformity.

(Signature)	(Signature)	(Signature)	(Signature)
Candidate	Co-supervisor	Supervisor	Principal

CERTIFICATE OF FACILITIES AVAILABLE

This is to certify that the facilities for work on the subject of thesis titled **"A STUDY ON CLINICAL AND RADIOLOGICAL OUTCOME OF PROXIMAL TIBIA FRACTURE WITH DUAL PLATING"** exist in the Department of Orthopaedics, DMC&H, Ludhiana and will be provided to be candidate. We will see that the data being included in the thesis are genuine and is collected by the candidate himself under our supervision and guidance.

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Likely date of appearing in PG examination	MAY 2023
Date of enrollment	30 JUNE 2020
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Approved: Yes / No

Dr. Sandeep Puri
Chairperson
Research Committee

Approved: Yes / ~~No~~

Prof. Arvind Malhotra
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BABA FARID UNIVERSITY OF HEALTH SCIENCES, FARIDKOT

PROFORMA FOR REGISTRATION OF SUBJECT FOR DISSERTATION

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4	DATE OF ADMISSION OF COURSE	26/07/2020
5	TITLE OF THE TOPIC	A STUDYON CLINICALAND RADIOLOGICAL OUTCOME OF PROXIMAL TIBIA FRACTURE WITH DUAL PLATING

6. BRIEF RESUME OF THE INTENDED WORK

6.1 NEED FOR THE STUDY

The tibia plateau is amongst the most important weight bearing regions of the human body. Intra-articular fractures of the proximal end of tibia are serious complex injuries and difficult to treat. Proximal tibia fractures account for 1.2% of all fractures in adults [1]. Such injuries generally result due to high energy trauma, majority due to road traffic accidents and the rest are sports related or fall from height. Tibia plateau fractures are generally classified according to methods developed by **SCHATZKER**. This classification divides tibia plateau fractures into six types:

Schatzker I: wedge-shaped pure cleavage fracture of the lateral tibia plateau, originally defined as having less than 4 mm of depression or displacement.

Schatzker II: splitting and depression of the lateral tibia plateau; namely, type I fracture with a depressed component.

Schatzker III: pure depression of the lateral tibia plateau; divided into two subtypes: SchatzkerIIIa:with lateral depression and SchatzkerIIIb: with central depression.

Schatzker IV: medial tibia plateau fracture with a split or depressed component.

Schatzker V: wedge fracture of both lateral and medial tibia plateau.

Schatzker VI: transverse tibialmetadiaphyseal fracture, along with any type of tibia plateau fracture (metaphysealdiaphyseal discontinuity).

As per the Schatzker classification bicondylar tibia plateau fracture falls under type V and VI [2]. Surgical fixation of bicondylar tibia plateau fracture is complicated because of metaphyseal and articular comminution and the frequent occurrence of associated soft tissue injuries. Treatment goals include restoration of articular congruity and alignment in the lower extremity and preservation of soft tissues and achieving functional range of knee motion. To achieve these goals open reduction and internal fixation is mandatory. For open reduction and internal fixation of bicondylar tibia plateau fractures, several operative treatment options can be used like-

a. Isolated lateral locking plate

b. Dual plating with lateral locking plate and posteromedial buttress plate

c. Hybrid external fixator

d. Ilizarov

e. LISS(less invasive stabilisation system)

Each technique has its own merits and demerits. The use of Isolated Lateral Locking plate and Dual Plates is still a debate. Patients treated with isolated lateral locking plates had a high risk of loss of reduction and increased incidence of malunion[4]. Lasanianos et al. showed that collapse of medial tibia plateau occurred in isolated lateral locking plates when he compared the biomechanical properties of intramedullary nail, dual plates and isolated lateral locking plates [5]. While Ilizarov fixation and Hybrid external fixation seems reasonable methods of fixation of these fractures, there are a few problems including the insufficient fracture reduction [6] ,inconvenience of an external fixator that requires careful maintenance, possibility of pin tract infections, joint capsule penetration with resultant septic arthritis [4], subsequent collapse of fracture fragments [3], and prolonged hospitalization [7]. However they are useful in the treatment of open schatzker type v and vitibial plateau fractures [5]. Though LISS (Less Invasive Stabilization System) permits direct fracture reduction; fixed angle construct, percutaneous sub muscular implant, the cost is high. Gosling et al. reported significant malreduction in 16 of 69 bicondylar fractures treated with LISS[6]. Dual Plating is preferred over other techniques as it has several advantages: Better visualisation of fracture fragments, especially posteromedial fragment and articular surface [6], dual incision reduces wound complications [6], both lateral and medial columns are fixed to obtain stability, achieves interfragmentary compression [4], rigid construct [4].

Dual plating via two incision techniques has received recent support because it allows for direct visualization of the articular reduction while minimizing the need for stripping off the soft tissue in the fracture area.

So, aim of our study is to assess the clinical and radiological outcome of surgically treated proximal tibia fracture with dual plating.

Dual plating has become a widely accepted method of internal fixation for complex bicondylar tibia plateau fractures. However, frequent soft tissue problems have prompted the search for less-invasive methods of treatment. External fixation and hybrid types of fixation have been tried with varying amounts of success. Unfortunately, their risk profile with regard to soft tissue infection has not been optimal, and articular reduction may be more difficult to achieve indirectly. The advent of FAP(fixed angle plates) has brought new strategies for these complicated injuries[8,9]. By reducing the number of incisions and overall soft tissue stripping, it is felt that their use could decrease the risk of infection and delayed union. FAP has also been proposed to offer increased stability in osteoporotic bone [8]. The obvious concern with this type of fixation has been the absence of a medial buttress, which might subsequently permit varuscollapse, that does not occur in dual tibia plating.

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6.2 REVIEW OF LITERATURE

SHAH T et al [10] conducted a prospective analytical cohort study from 2014 to 2016. They treated twenty eight patients with schatzker type v and type vi tibia plateau fracture with dual plating via lateral plate through an anteromedial approach and a medial plate through an posteromedial approach using Rasmussen functional criteria to evaluate final outcome. They found that mean range of motions at 14 weeks follow up was 110 degree. The mean time to union was 14.6 weeks as per Rasmussen criteria. They concluded that bicondylartibial plateau fractures (type v and vi)with dual plating gives excellent function outcome with a very low complication rate.

CANER CITAK et al [11] conducted a study from 2010 to 2015 on patients who underwent surgical treatment due to bicondylar tibia plateau fracture in which they divided 10 patients each in two groups, one group was employed for dual locking plating system and in the other group for only lateral locking plate . In both the groups, clinical and radiological outcome were rated according to Rasmussen functional score and Rasmussen radiological score. They concluded that in bicondylar tibia plateau fracture without posteromedial fragment, the lateral locking plate fixation technique showed the similar clinical and radiological outcome as dual plate fixation technique.

KYE-YOUL CHO et al [12]conducted a study on ten patient who are being followed after a treatment of schatzker type v and vi tibia plateau fractures with a midline longitudinal incision and dual plating. Clinical outcomes evaluated using range of motion, visual analogue scale and radiological outcome using bony union time, medial proximal tibial angle and posterior proximal tibial angle. They concluded that schatzker type v and vi tibia plateau fractures with a midline longitudinal incision and dual plating resulted in satisfactory clinical and radiological outcomes.

DAVID P. BAREL et al [13]conducted a retrospective study to evaluate the perioperative results and functional outcomes of medial and lateral plate stabilization through anterolateral and posteromedial surgical approaches of comminuted bicondylar tibia plateau fracture over a

seventy seven month period in which bicondylar tibia plateau fractures were treated with medial plate and lateral plate through two exposures(anterolateral and posteromedial),in which mean duration of follow up was of fifty nine months. Using MFA(musculoskeletal function assessment function) questionnaire to evaluate functional outcome and immediate biplanar postoperative radiographs to evaluate the quality of reduction. They concluded that medial and lateral plate stabilization of comminuted bicondylar tibia plateau fractures through medial and lateral surgical approaches is a useful treatment method; however, residual dysfunction is common. Accurate articular reduction was possible in about half of patients and was associated with better outcomes within the confines of the injury severity.

DRMANJUNATH J et al [14] conducted a prospective study to assess the clinical and functional outcome of surgically treated bicondylar tibia schatzker type v and vi plateau fractures with dual plating at SSIMS-RC, Davanagere during August 2015 to August 2018 in which total number of cases studied were 30, in whichfollowing patient are included in a study- all skeletal mature patients with proximal tibia fracture Schatzker type V and VI (>18years), AO Muller type 41-C1, 41-C2, 41-C3, Gustilo-Anderson type I and II compound proximal tibia fractures and following patients are excluded with Gustilo-Anderson type 3 compound tibial plateau fractures, children with proximal tibial fractures in whom the growth plate is intact, patients with pathological proximal tibial fractures apart from osteoporosis.

HonkonenJarvinen Criteria used for radiological, functional and clinical outcome. They concluded that surgical management of bicondylar tibia plateau fractures with dual plating gives excellent anatomic reduction, accurate axial and articular alignment with rigid internal fixation by dual locking plate, achieving a stable and functional knee joint.

THOMAS F. HIGGINS et al [15] conducted a designed study to test the comparative strength of lateral-only locked plating to medial and lateral non locked plating in a cadaveric model of a bicondylar proximal tibia plateau fracture in which ten matched pairs of human cadaveric proximal tibia specimens were used for biomechanical testing. Cyclic

loading using a materials testing device simulated initial range of motion and load bearing following surgical repair. Subsidence of the medial and the lateral condyles was measured following 10,000 cycles from 100N to 1,000N; the maximum load to failure on the medial condyle for both plate constructs was also measured. On the lateral side, dual plating (DP) allowed an average of 0.68 plus minus 0.14 mm of subsidence, compared with 1.03 plus minus 0.27 mm for the ed-angle platefix. On the medial side, DP allowed an average of 0.78 plus minus 0.15 mm of subsidence, compared with 1.51 plus minus 0.32 mm for the fixed angle plate. The results of this study demonstrate that dual-plate fixation allows less subsidence in this bicondylar tibia plateau cadaveric model when compared to isolated locked lateral plates.

MICHAEL R. RUFFOLO et al [16] conducted a retrospective study to characterize the rate of complications after operative fixation of bicondylar (OTA/AO 41-C) tibia plateau fractures and to evaluate the contribution of common risk factors in which one hundred thirty-eight patients older than 18 years with 140 bicondylar tibia plateau fractures participated in study who underwent open reduction and internal fixation using medial and lateral plate construct through 2 incisions in which the overall major complication rate was 27.9%: 23.6% deep infection and 10.0% nonunion. Open fractures were associated with a higher rate of infection:

definitive fixation was associated with significantly fewer deep infections 43.8% versus 21.0% for closed injuries. Fasciotomy closure before compared with internal fixation with open fasciotomy wounds: 11.8% versus 50.0%.The presence of compartment syndrome, tobacco use, diabetes, and timing of surgery had no statistically significant association on the rate of infection or nonunion. They concluded that nonunion and deep infections occur commonly after staged open reduction and internal fixation of high-energy tibia plateau fractures.Open fractures and open fasciotomy wounds at the time of internal fixation are associated with higher rates of infection.

YASH PARIKH et al [17]conducted a prospective study from fromFrom April 2017 to June 2019 included 30 cases of closed proximal tibia classified as Schatzker type v and vi fractures(bicondylar tibia plateau fractures) managed by dual plating.Patients were followed up at 2^{nd} , 6^{th} , 12^{th} and 24^{th} postoperative weeks.Average Oxford Score was used and concluded that open reduction and internal fixation using dual plates is an excellent method of treatement of closed bicondylartibial plateau schatzker type V and VI.

Meng-HsuanLee[18] conducted a retrospective study on 76 patients with TPF, Schatzker types V and VIfrom June 2006 to May 2009 in our institute. Excluding patients who expired due to other medical conditions and without complete follow-up, 45 patients were sorted out of 75 patients .Out of 45 patients, 15 patients were assigned as group I, were treated with unilateral locking plating. Other 19 patients assigned as group II, were treated with classic dual plates. The residual 11 patients, assigned group III, were treated with hybrid dual plates (one lateral approach locking compression plate (LCP) + medial anti-gliding plate). All patients were under periodic followed up at about 6 weeks interval for at least 18 months postoperatively.In group I, 13 cases achieved solid bony union without obvious traumatic OA change, limitation of ROM,or malalignment. In groups II and III, 15 and 10 patients reached the same goal, respectively. By analysis of therecorded parameters with statistical software (SPSS 12.0), there were five parameters with significant difference,including Schatzker classification, operation time, staged treatment or not, hospitalization period, and hardware impingement. They concluded that there was no significant statistical difference of union rate between these three groups.Based on clinical follow-up, several key points were emphasized: (1) Soft tissue problems should be kept inmind, and usage of locking plate can reduce the discomfort of hardware impingement effectively. (2) The single lateral approach technique for TPF with locking plate results in less operation time and shorter hospitalizationperiod. (3) If the medial buttress cannot be established

by reduction of the lateral fracture, then open reduction of the medial side is necessary and buttresses the medial fragment by dual plates.

6.3 AIMS AND OBJECTIVES OF THE STUDY

AIM: To assess the clinical and radiological outcome of surgically treated proximal tibia fracture with dual plating.

OBJECTIVES:

- To assess the clinical outcome associated with dual plating in terms of
  a. knee range of movements
  b. pain relief
  c. return to daily activities and work
- To assess the radiological outcome of fractures after initial fixation with dual plating

7.0 MATERIALS AND METHODS

1) Patients admitted in Dayanand Medical College And Hospital from 1stjune 2019 till 31st march 2022 will be included in this study. Patients willing to participate in the study will be included.

2) The old cases will be followed up using the patient records as well as personal and telephonic interview and new cases will be followed up using the proforma for 6 months.

3) The results of the study will be based on thefunctional and radiological outcome of the patients after follow up period of 6 months from the date of surgery.

5) The radiological outcome will be based on the **ModifiedRasmussen Score for radiological assessment** and clinical outcome will be based on **Modified Rasmussen Score for clinical assessment.**

The trauma patients coming to casualty in Dayanand Medical College and Hospital will be initially managed by the ATLS protocol: airway, breathing, circulation and monitoring all the vitals of patient accordingly i.e blood pressure, heart rate, oxygen saturation. After managing the patient hemodynamically by transfusing blood for blood loss, look for other injuries and appropriately get the x rays done accordingly i.e x ray PBH view, x-ray thigh with whole leg focusing on the knee joint for the proximal tibia fractures. Later patient who will be diagnosed as proximal tibia fractures with open wound will be given above knee slab, after washing the open wound with saline, betadine, and dressing. All the basic investigation -complete blood count, renal function test, ABG, chest xray will be sent, patient simultaneously will be administered prophylactic antibiotic to prevent sepsis and pain killers for pain. Then patient will be taken to operation theatre with open wounds for debridement. After assessing the wound size, level of contamination of wound, external fixator applied as temporary fixation of proximal tibia fractures. But if no open wound present, diagnosis of closed proximal tibia fracture being made after assessing the x rays, grading the fracture according to schatzker classification. Closed proximal tibial fractures schatzker type v and vi are managed by dual plating (lateral plate through an anterolateral approach and medial plate through

posteromedialapproach) as a permanent fixation method. Physiotherapy like non weight bearing walking with walker of the affected side and quadriceps exercises started on first postoperative day, partial weight bearing started after 6 weeks till fracture union. Thereafter, full weight bearing started. Serial follow up of the patients are made at 4 weeks, 6weeks, 3months, 6 months to know the bone union and reduction.

Modified Rasmussen Score for clinical assessment is used to assess the clinical outcome and Modified Rasmussen Score for radiological assessment is used to assess the radiological outcome.

SURGICAL TECHNIQUE:

Dual plating is done by two approaches being described as:

Medial plate through posteromedial approach

Lateral plate through anterolateral approach

Posteromedial approach refers to the method in which the incision is performed at the rear boundary of pesanserinus in parallel with the sartorius muscle.

Procedure:

- with the knee in slight flexion make a straight or slightly curved incision running from medial epicondyle towards the posteromedial edge of tibia.
- open the fascia and expose the pesanserinus.
- retract the pes anteriorly and the gastrocnemius posteriorly and distally.
- identify the meniscus and incise the capsule between the meniscus and the edge of the tibialplateau,thus gaining access to the knee joint.
- exposure of the anteromedial part of the proximal tibia is possible by a subcutaneous dissecting anteriorly.
- thepes can be retracted posteriorly to expose the fractured site.

Anterolateral approach refers to the method in which the incision is performed 1-2 cm lateral to the anterior boundary of the tibia

Procedure:

- with the knee slightly flexed, make a straight incision lateral to the patella.
- open the deep fascia anterior to the iliotibial tract.
- release the proximal attachment of the tibialis anterior muscle.
- if necessary release the iliotibial tract by incising it or taking a small piece of bone from the gerdy's tubercle.
- avoid the peroneal nerve which runs posterior to the biceps femoris tendon at its attachment to the fibular head.
- to expose the knee joint, make a horizontal capsulotomy between the deep edge of the meniscus and the tibia to expose the fractured site.

A variety of surgical approaches have been used to treat tibial plateau fractures, including the anterolateral single incision, the midline longitudinal incision and the lateral and posteromedial dual incisions. The midline longitudinal incision and the lateral and posteromedial dual incisions are mainly used for high-energy Schatzker type V and VI fractures because these fractures require reduction and fixation of both medial and lateral condyles. The midline longitudinal incision refers to the method in which the size of the incision depends on the length of the plate and the skin incision starts from the upper pole of the patella. The midline longitudinal incision has the advantage of providing full exposure of the fracture with lifting of the soft tissue flap including the subcutaneous tissue and fascia, which helps ensure accurate observation and reduction of the fracture [19]. However, previous studies have reported that fixation with a midline longitudinal incision can lead to infection because this approach requires a wide exposure that can damage the skin and surrounding soft tissues [21,22]. The dual approach i.e with anterolateral and posteromedial incisions had been resulted in lower rates of inflammation and infection than the midline longitudinal incision[18]. The medial approach refers to the method in which the incision is performed at the rear boundary of the pesanserinus in parallel with the sartorius muscle. The anterolateral approach refers to the method in which the incision is performed about 1−2 cm lateral to the anterior boundary of the tibia; this approach has

fewer wound complications because the soft tissues near the fracture site are protected. However, the anterolateral and posteromedial approaches also have wound complications, such as the delay in tissue healing and deep infection, though in a small number of cases[23].

MODIFIED RASMUSSEN SCORE FOR CLINICAL ASSESSMENT will be used to asses the clinical outcome and **MODIFIED RASMUSSEN SCORE FOR RADIOLOGICAL ASSESSMENT** will be used to asses the radiological outcome.

Radiological outcomes can be evaluated in terms of bony union and the reduction status of the tibia plateau. Bony union was defined as the radiologically proven connections of cortical bone in more than 3 cortices during the follow-up period. Nonunion was defined as the absence of union at 6 months after surgery[24]

7.1 SOURCE OF DATA

It will be a retrospective study of cases from 1st June2019to1st June2020 and prospective study from 1st June 2020 to 31st March 2022 for all the patients admitted in Dayanand Medical College and Hospital under department of orthopaedics diagnosed as schatzker type v and vi bicondylar tibia fracture and selected for dual plating after considering the inclusion and exclusion criteria.

7.2 METHOD OF COLLECTION OF DATA

Collection of data as per the proforma with consent from the patients admitted in the Orthopaedic department, Dayanand Medical College And Hospital

INCLUSION CRITERIA

- Patient in age group above 18 years
- Patients giving consent to participate in study
- Closed and open fracture schatzker`s type v and vi
- Follow up upto 6 months duration

EXCLUSION CRITERIA

- Patients in age group 18 years and above
- Patients who refused to give consent
- Patients failing to follow up

- Patients with vascular injury

Duration of study: The patients operated at Dayanand Medical College and Hospital from 1st June 2019 to 31st March 2022 followed upto 6 months will be included in the study.

Outcome: This study will analyse the clinical and radiological outcome of patients having schatzker type v and vi proximal tibia fracture being managed by dual plating

Statistical Analysis: Data will be described in terms of range; mean ±standard deviation (± SD), frequencies (number of cases) and relative frequencies (percentages) as appropriate. All statistical calculations will be done using (Statistical Package for the Social Science) SPSS 21version (SPSS Inc., Chicago, IL, USA) statistical program for Microsoft Windows

7.3 DOES THE STUDY REQUIRE ANY INVESTIGATIONS OR INTERVENTIONS TO BE CONDUCTED ON PATIENTS OR OTHER HUMANS OR ANIMALS? IF SO, PLEASE DESCRIBE BRIEFLY.

This study requires surgical intervention in patients with SCHATZKER Type V and VI Proximal Tibia Fracture

7.4 HAS ETHICAL CLEARANCE BEEN OBTAINED FROM YOUR INSTITUTION IN CASE OF 7.3?

Yes, attached here with

LIST OF REFERENCES

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PROFORMA

S. NO:

AGE: SEX:

NAME: ADMISSION NO:

MRD NO:

DATE OF ADMISSION: DATE OF DISCHARGE:

RELIGION: OCCUPATION:

DATE OF INJURY:

MODE OF INJURY: ROAD SIDE ACCIDENT/DOMESTIC FALL/OTHER

EMPLOYMENT STATUS: EMPLOYED/DEPENDENT

LOCAL EXAMINATION:

OPEN/CLOSED FRACTURE

GRADE OF FRACTURE:SCHATZKER V/VI

X RAY FINDINGS:

FRACTURE CLASSIFICATION:AO/OTA TYPE 41 C

SITE OF FRACTURE:

DISPLACED/UNDISPLACED FRACTURE

OPERATION/PROCEDURE DONE:

ANAESTHESIA USED: GENERAL ANAESTHESIA/SPINAL ANAESTHESIA/COMBINED SPINAL ANAESTHESIA

TYPE OF FIXATION:OPEN REDUCTION AND INTERNAL FIXATION/CLOSED REDUCTION AND INTERNAL FIXATION

DATE OF SURGERY:

APPROACH:

COMPLICATIONS:

Signature of Candidate **Signature of Supervisor**

- INFECTION:

DATE OF OCCURENCE OF INFECTION-

DURATION BETWEEN SURGERY AND INFECTION-

- NON-UNION
- HARDWARE PROBLEMS:

PAIN DUE TO IRRITATION BY IMPLANT

LOOSENING OF SCREWS

- OTHERS;

ADDITIONAL PROCEDURES:`

• REVISION AND BONE GRAFTING

• DEBRIDEMENT AND IRRIGATION

• OTHER-

FOLLOW UP:

✓ X RAY BILATERAL KNEE ANTEROPOSTERIOR AND LATERAL VIEW(IN CASE OF BOTH LOWER LIMBS INVOLVED)

✓ X RAY UNILATERAL(RIGHT/LEFT) KNEE JOINT- ANTEROPOSTERIOR AND LATERAL VIEW

RADIOLOGICAL OUTCOME ASSESSED BY:

MODIFIED RASMUSSEN CRITERIA :

PARAMETERS SCORE

- ARTICULAR DEPRESSION

NONE(3)

<5MM(2)

6-100MM(1)

>10MM(0)

Signature of Candidate **Signature of Supervisor**

- CONDYLAR WIDENING

<5MM(2)

6-10MM(1)

>10MM(0)

- VARUS-VALGUS ANGULATION

NONE(3)

<10 DEGREE(2)

10 TO 20 DEGREES(1)

>20 DEGREES(0)

- OSTEOARTHROSIS

NONE/NO PROGRESS(1)

PROGRESSION BY 1 GRADE(0)

PROGRESSION BY >1GRADE(-1)

➢ MAX SCORE ___out of 10

✓ EXCELLENT 9-10

✓ GOOD 7-8

✓ FAIR 5-6

✓ POOR <5

Signature of Candidate **Signature of Supervisor**

CLINICAL OUTCOME ASSESSED BY:

MODIFIED RASMUSSEN CRITERIA

PARAMETERS SCORE

- PAIN

NONE(6)

OCCASIONAL(5)

STABBING PAIN IN CERTAIN POSITION(3)

CONSTANT PAIN AFTER ACTIVITY(1)

SIGNIFICANT REST PAIN(-3)

- WALKING CAPACITY

NORMAL WALKING CAPACITY FOR AGE(6)

WALKING OUTDOOR FOR MORE THAN 1HR(5)

WALKING OUTDOOR 15 MINS TO 1HR(3)

WALKING<15 MINS(1)

WALKING INDOOR ONLY(0)

WHEELCHAIR OR BED RIDDEN(-3)

- KNEE EXTENSION

NORMAL(4)

LACK OF EXTENSION <10 DEGREE(2)

LACK OF EXTENSION >10 DEGREE(0)

LACK OF EXTENSION >20 DEGREE(-2)

Signature of Candidate **Signature of Supervisor**

- TOTAL RANGE OF MOTION

FULL(6)

AT LEAST 120 DEGREE(5)

AT LEAST 90 DEGREE(3)

AT LEAST 60 DEGREE(1)

<60 DEGREE(-3)

- STABILITY

NORMAL STABILITY IN EXTENSION AND 20 DEGREE FLEXION(6)

ABNORMAL SATBILITY IN 20 DEGREE FLEXION(4)

INABILITY IN EXTENSION <10 DEGREE(2)

INABILITY IN EXTENSION >10 DEGREE(0)

- POWER OF QUADRICEPS

GRADE 5(2)

GRADE 3-4(1)

GRADE <3(- 2)

➢ MAXIMUM SCORE __out of 30

✓ EXCELLENT 28-30

✓ GOOD 24-27

✓ FAIR 20-23

✓ POOR <20

Signature of Candidate **Signature of Supervisor**

INFORMED PATIENT CONSENT

Date: _____

I.....D/o, W/o, S/o.....
.....am willing to participate in the study **"A STUDY ON CLINICAL AND RADIOLOGICAL OUTCOME OF PROXIMAL TIBIA FRACTURE WITH DUAL PLATING"** The procedure with its complications has been explained to me in local vernacular language. I have fully understood that no special tests and extra expenditure in any form, merely for the purpose of thesis is being carried out. I am free to opt out the study any time without assigning any reason.

.....
Signature of the Witness

.....
Signature of the patient

Name:

Signature of Candidate

Signature of Supervisor

मरीज अनुमति फार्म

तिथि _____

मैं _____ पत्नी/पुत्र/पुत्री _____

निवासी _____

इस शोधकार्य **"A STUDY ON CLINICAL AND RADIOLOGICAL OUTCOME OF PROXIMAL TIBIA FRACTURE WITH DUAL PLATING"** में भाग लेने के लिए सहमत हूँ। मैं इस शोधकार्य में भाग लेने के लिए अपनी स्वेच्छा से तैयार हूँ। मैं पुष्टि करता/करती हूँ की यह स्वीकृति देने के लिए मुझे कोई आर्थिक प्रलोभन नहीं दिया गया और न ही दबाव डाला गया है। मुझे इस शोधकार्य का उद्देश्य स्पष्ट कर दिया गया है और मुझे यह विश्वास है की यह विज्ञान और मानवता के लाभ के लिए है। मुझे इस शोधकार्य में होने वाले जोखिम के बारे में समझा दिया गया है और मेरी समझ में यह जोखिम बहुत मामुली है।

मैं इस शोधकार्य में भाग लेने के सम्बन्ध में किसी भी समय अपनी अस्वीकृति व्यक्त कर सकता/सकती हूँ और मेरे अस्वीकृति व्यक्त करने का मेरे इलाज पर कोई प्रभाव नहीं पड़ेगा।

_____ _____

गवाह के हस्ताक्षर रोगी के हस्ताक्षर/अंगूठे का निशान

नाम: नाम:

_____

अन्वेषक के हस्ताक्षर

_____

विद्यार्थी के हस्ताक्षर

ਮਰੀਜ਼ ਰਜ਼ਾਮੰਦੀ ਫਾਰਮ

ਮਿਤੀ_____

ਮੈ_____ਪਤਨੀ/ਪੁੱਤਰ/ਪੁੱਤਰੀ_____

ਵਾਸੀ _____

"A STUDY ON CLINICAL AND RADIOLOGICAL OUTCOME OF PROXIMAL TIBIA FRACTURE WITH DUAL PLATING" ਤੇ ਚਲ ਰਹੀ ਖੋਜ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਰਜ਼ਾਮੰਦ ਹਾਂ। ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਮੈ ਆਪਣੀ ਮਰਜ਼ੀ ਨਾਲ ਤਿਆਰ ਹਾਂ। ਮੈ ਇਹ ਦਸਣਾ ਚਾਹੁੰਦਾ ਹਾਂ/ ਚਾਹੁੰਦੀ ਹਾਂ ਕੇ ਇਹ ਰਜ਼ਾਮੰਦੀ ਦੇਣ ਵਾਸਤੇ ਮੈਨੂ ਕਿਸੇ ਵੀ ਤਰਾਂ ਦਾ ਲੋਭ-ਲਾਲਚ ਨਹੀ ਦਿੱਤਾ ਗਿਆ ਅਤੇ ਨਾ ਹੀ ਕੋਈ ਦਬਾ ਪਾਇਆ ਗਿਆ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਦਾ ਮਨੋਰਥ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਭਰੋਸਾ ਦਵਾਇਆ ਗਿਆ ਹੈ ਕੇ ਇਹ ਖੋਜ ਵਿਗਿਆਨ ਅਤੇ ਮਾਨਵਤਾ ਦੀ ਭਲਾਈ ਲਈ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਵਿਚ ਹੋਣ ਵਾਲੇ ਖਤਰੇ ਬਾਰੇ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਯਕੀਨ ਹੈ ਕੇ ਇਹ ਖਤਰਾ ਬਹੁਤ ਮਾਮੂਲੀ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਦਾ ਢੰਗ – ਤਰੀਕਾ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ।

ਮੈ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਬਾਰੇ ਆਪਣੀ ਰਜ਼ਾਮੰਦੀ ਕਿਸੇ ਵੀ ਸਮੇ ਵਾਪਸ ਲੈ ਸਕਦਾ ਹਾਂ/ ਸਕਦੀ ਹਾਂ ਅਤੇ ਮੇਰੀ ਰਜ਼ਾਮੰਦੀ ਵਾਪਸ ਲੈਣ ਦਾ ਮੇਰੇ ਇਲਾਜ ਤੇ ਕੋਈ ਅਸਰ ਨਹੀ ਹੋਵੇਗਾ।

_____ _____

ਗਵਾਹ ਦੇ ਹਸਤਾਖਰ ਮਰੀਜ਼ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____ ਮਿਤੀ_____

ਪਤਾ _____ ਪਤਾ _____

_____

ਨਿਰੀਖਕ ਦੇ ਹਸਤਾਖਰ

_____

ਸਿਖਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ